ADDITIONAL OBSERVATIONS *on the* PROPORTION *of* REAL ACID *in the* THREE ANTIENT KNOWN MINERAL ACIDS, *and on the* INGREDIENTS *in various* NEUTRAL SALTS *and other* COMPOUNDS. *By* RICHARD KIRWAN, *Esq. L.L.D. F.R.S. and M.R.I.A.*

THE fundamental experiments on which the proportion of real acid in the three mineral acids antiently known, and alſo the proprortion of ingredients in many neutral ſalts, were determined, I have already ſet forth in a paper to be found in the IVth Vol. of the Tranſactions of this Academy. In that paper I have inſerted tables of the quantity of ſtandard acid exiſting in 100 parts of each of the acid liquors, of given ſpecific gravities, and alſo in each of the neutral ſalts therein mentioned; the mode of expreſſing the quantity of acid I had then adopted I ſince diſcovered to be very inconvenient, as in ſome of theſe neutral ſalts an acid ſtill ſtronger than the aſſumed ſtandard was found to exiſt. But I have there alſo noticed that the ſtrongeſt vitriolic acid now known, exiſted in *vitriolated tartarin*, the ſtrongeſt nitrous acid in *nitrated ſoda*, and the ſtrongeſt muriatic acid in *muriated tartarin*; Read 16th Dec. 1797.

 Acids

Acids of ſuch ſtrength I have therefore denominated *real*, as either containing no water or containing only as much as is neceſſary to their eſſential compoſition, as far as this is at preſent known. The method of transforming the expreſſion *ſtandard* into that of *real*, I have there alſo given p. 67, and by it have formed the table I here preſent; this latter expreſſion I therefore now employ in every caſe inſtead of that of *ſtandard*, together with the ſubſtitution of a more commodious expreſſion of the ſtrength of acids: The deſign of this paper is alſo to exhibit an illuſtration or amendment of ſeveral of the determinations contained in my laſt, which being for the moſt part ſingle, required confirmation by ſhewing their agreement with the experiments of ſeveral of the moſt eminent chymiſts made ſince the publication of mine, that is ſince the year 1791, with a few made nearly at the ſame time. In my former paper I compared my reſults with thoſe of Bergman and Wenzel, they being almoſt the only perſons who had made this ſubject the principal object of their enquiry, and had purſued it to a conſiderable extent; in each particular inſtance I have traced the reaſon of the difference of their reſults from my own when it was ſuch as to deſerve notice, and I ſhall not here repeat what I have there ſaid; but I cannot avoid again mentioning one general ſource of error attending the mode of inveſtigation adopted by both and yet noticed by neither, namely the loſs that many neutral ſalts undergo dering evaporation, a loſs whoſe diſcovery is of conſiderable importance, not only to the preſent inquiry, but alſo to the

the conduct of several manufactures, particularly to that of saltpetre, and hence noticed by Mr. Lavosier, 15 An. Chy. 254. On this head however I hope the Academy will soon receive the fullest information, as our worthy member, Mr. Higgins, has at my request undertaken to examine its reality and extent with respect to a considerable number of the most known among these salts.

Though Bergman and Wenzel should have conducted their experiments nearly in the same manner, as far as we can judge from the mode prescribed by Mr. Bergman in his notes on Scheffer, published in 1779, yet his results differ considerably in many instances from those of Wenzel, and appear to me far more faulty, the cause of which seems to me to be, that he has in most cases departed from the method he had originally proposed to follow, and supposed quantities of water of crystallization to exist in various substances without sufficient reason, or at least without assigning any such. Thus he tells us that pellucid calcareous spars lose only 34 per cent. of fixed air by solution in acids, whereas the daily experience of all chymists shews them to lose from 43 to 44 per cent. but 11 of these he supposes to be water, because by distillation he could not obtain more than 34 per cent. of fixed air, a method now well known to be defective, as from the porosity of earthen retorts, the inefficacy of lutes, and the insufficiency of the heat applicable to those of glass, the true quantity of fixed air can never be thus obtained. Mr. Cavendish could obtain from 311 grains

of Carrara marble only 1 grain of water *, and Florian de Bellevue, who lately has particularly enquired into this matter, ſays, marbles contain no water, or ſcarce any; and it is of the granularly cryſtallized that he ſpeaks ‡. Dr. Watſon alſo makes the ſame remark.

To tartar vitriolate Bergman has alſo aſſigned 8 grains of water of cryſtallization, whereas when dried even in a heat of 70 degrees only, except it contains an exceſs of acid, it retains not even 1 per cent. of water. To nitre he aſſigns even 18 per cent. a quantity ſo great that he can ſcarce be ſuppoſed to have meant water of cryſtallization. Lavoſier, who by profeſſion muſt have been well acquainted with a property ſo obvious, tells us on the contrary that it contains little or none, 15 An. Chy. 256. Mr. Keir allows it when not well dried about 2,5 per cent. Wenzel, on the other hand, took but little notice of the water of cryſtallization, and his miſtakes are not ſo conſiderable, moſt of them independently of the ſource of error already mentioned originated from the ſuppoſition of a fictitious ſubſtance which he called *Cauſticum*, the unheeded decompoſition of nitre when ſtrongly ignited, and the ſuppoſition that acids, when the compounds into which they enter are heated to redneſs, either retain no water or at leaſt a conſtant and not a variable quantity of it; this is indeed an error inherent in the method purſued by him, Bergman

* Phil. Tranſ. 1766, p. 167. ‡ 41 Roz. 94.

Bergman and myfelf in my firft effays. But he alfo followed another method, which preferved him from many miftakes, which was to eftimate the quantity of the ftrongeft acid in a given quantity of vitriolic acid, v: z: 240 grains by the quantity of it retained during ignition in tartar of vitriolate, and in 240 grains muriatic acid by the quantity retained in muriated tartarin, for in effect thefe acids, as I have found, contain leaft water in thefe compounds; this advantage however he fometimes loft by the decompofitions arifing from ignition, particularly in his experiments on metallic fubftances.

To render this paper ftill more ufeful, I fhall lay before the Academy fome important determinations of the proportion of ingredients in compounds of which I had not myfelf treated, and are either not generally known, or fcattered in divers treatifes not eafily collected, to moft of which however I have added my own experiments.

When alkalies or earths combined with fixed air are diffolved in acids, though far the greater part of the fixed air is expelled during the folution, yet fome portion of it is often retained, and may in fome degree alter the fp. grav. of the folution; this circumftance I did not recollect till lately; it was firft noticed by Mr. Cavendifh, Phil. Tranf. 1766, p. 172, and afterwards by Bergman in his notes on Scheffer, § 51, but more explicitly by Scheele, Chy. An. 1786,

p. 13,

p. 13, and by Butini on Magnefia, p. 149. As to the ufe refulting from refearches of this nature it were fuperfluous to attempt to prove it at this day, the recourfe which the moft eminent analyfts have been obliged to have to it in particular inftances, as will prefently appear, fufficiently evinces it. " Inquiries of this kind (fays " Mr. Fourcroy) are more difficult and delicate than thofe which " have hitherto been made on falts; whatever requires a precife " knowledge of quantities and proportions, prefents difficulties fo " great as often to appear infurmountable, yet without this know- " ledge no progrefs can now be made in chymiftry," 10 An. Chy. 325; and according to Bergman, " Ufus cognitæ proportionis prin- " cipiorum ingredientium egregius eft et multifarius." 1 Bergm. 137. chap. 1. § 1.

TABLE

T A B

O F T

QUANTITY O

In 100 Parts of Vitriolic, Nitrou
different Densities, at th

In *Vitriolic Acid* of different Densities, at the Temperature of 60°.				In *Nitrous Acid* ... Te...
100 Parts Sp. Gravity.	Real Acid.	100 Parts Sp. Gravity.	Real Acid.	100 Parts Sp. Gravity.
2,0000	89,29	1,4666	44,64	1,5543
1,9859	88,39	1,4427	43,75	1,5295
1,9719	87,50	1,4189	42,86+	1,5183
1,9579	86,61	1,4099	41,06	1,5070
1,9439	85,71	1,4010	41,07	1,4957
1,9299	84,82	1,3875	40,18	1,4844
1,9168	83,93	1,3768*	39,28	1,4731
1,9041	83,04+	1,3663	38,39	1,4719
1,8914	82,14	1,3586	37,50	1,4707
1,8787	81,25	1,3473	36,60	1,4695
1,8660	80,36	1,3360	35,71	1,4683
1,8543	79,46	1,3254	34,82	1,4671
1,8424	78,57	1,3149	33,93	1,4640
1,8306	77,68	1,3102	33,03	1,4611
1,8188	76,79+	1,3056	32,14	1,4582
1,8070	75,89	1,2951	31,25	1,4553

T A B L E

OF THE

UANTITY OF REAL ACI

Parts of Vitriolic, Nitrous and Marine Acid Liqu different Densities, at the Temperature of 60°.

Acid of different Densities, at Temperature of 60°.			In *Nitrous Acid* of different Densities, at the Temperature of 60°.				In *Marine A* ferent Densi Temperature
Real Acid.	100 Parts Sp. Gravity.	Real Acid.	100 Parts Sp. Gravity.	Real Acid.	100 Parts Sp. Gravity.	Real Acid.	100 Parts Sp. Gravity.
89,29	1,4666	44,64	1,5543	73,54	1,3364	41,91	1,196
88,39	1,4427	43,75	1,5295	69,86	1,3315	41,18	1,191
87,50	1,4189	42,86+	1,5183	69,12	1,3264	40,44	1,187
86,61	1,4099	41,96	1,5070	68,39	1,3212	39,71	1,183
85,71	1,4010	41,07	1,4957	67,65	1,3160	38,97	1,179
84,82	1,3875	40,18	1,4844	66,92	1,3108	38,34	1,175
83,93	1,3768*	39,28	1,4731	66,18	1,3056	37,50	1,171
83,04+	1,3663	38,39	1,4719	65,45	1,3004	36,77	1,167
82,14	1,3586	37,50	1,4707	64,71	1,2911	36,03	1,163
81,25	1,3473	36,60	1,4695	63,98+	1,2812	35,30+	1,159
80,36	1,3360	35,71	1,4683	63,24	1,2795	34,56	1,155
79,46	1,3254	34,82	1,4671	62,51	1,2779	33,82	1,151
78,57	1,3149	33,93	1,4640	61,77	1,2687	33,09	1,147
77,68	1,3102	33,03	1,4611	61,03	1,2586	32,35	1,1414
76,79+	1,3056	32,14	1,4582	60,30	1,2500	31,62	1,1396
75,89	1,2951	31,25	1,4553	59,56	1,2464	30,88	1,1358

B L E

H E

F REAL ACID

is and Marine Acid Liquors of
ne Temperature of 60°.

l of different Densities, at the mperature of 60°.			In *Marine Acid* of different Densities, at the Temperature of 60°.	
Real Acid.	100 Parts Sp. Gravity.	Real Acid.	100 Parts Sp. Gravity.	Real Acid.
73,54	1,3364	41,91	1,196	25,28
69,86	1,3315	41,18	1,191	24,76
69,12	1,3264	40,44	1,187	24,25
68,39	1,3212	39,71	1,183	23,73
67,65	1,3160	38,97	1,179	23,22
66,92	1,3108	38,34	1,175	22,70
66,18	1,3056	37,50	1,171	22,18
65,45	1,3004	36,77	1,167	21,67
64,71	1,2911	36,03	1,163	21,15
63,98+	1,2812	35,30+	1,159	20,64
63,24	1,2795	34,56	1,155	20,12
62,51	1,2779	33,82	1,151	19,60
61,77	1,2687	33,09	1,147	19,09
61,03	1,2586	32,35	1,1414	18,57
60,30	1,2500	31,62	1,1396	18,06
59,56	1,2464	30,88	1,1358	17,54

different Densities, at th

In *Vitriolic Acid* of different Densities, at the Temperature of 60°.			
100 Parts Sp. Gravity.	Real Acid.	100 Parts Sp. Gravity.	Real Acid.
2,0000	89,29	1,4666	44,64
1,9859	88,39	1,4427	43,75
1,9719	87,50	1,4189	42,86+
1,9579	86,61	1,4099	41,06
1,9439	85,71	1,4010	41,07
1,9299	84,82	1,3875	40,18
1,9168	83,93	1,3768*	39,28
1,9041	83,04+	1,3663	38,39
1,8914	82,14	1,3586	37,50
1,8787	81,25	1,3473	36,60
1,8660	80,36	1,3360	35,71
1,8543	79,46	1,3254	34,82
1,8424	78,57	1,3149	33,93
1,8306	77,68	1,3102	33,03
1,8188	76,79+	1,3056	32,14
1,8070	75,89	1,2951	31,25
1,7959	75,—	1,2847	30,35
1,7849	74,11	1,2757	29,46
1,7738	73,22	1,2668	28,57
1,7629	72,32	1,2589	27,68+
1,7519	71,43	1,2510	26,78
1,7416	70,54+	1,2415	25,89
1,7312	69,64	1,2320	25,—
1,7208	68,75	1,2210	24,10
1,7104	67,86	1,2101	23,21
1,7000	66,96	1,2009	22,32
1,6899	66,07	1,1918	21,43+
1,6800	65,18	1,1836	20,53
1,6701	64,28	1,1746	19,64
1,6602	63,39	1,1678	18,75
1,6503	62,50	1,1614	17,85
1,6407	61,61	1,1531	16,96
1,6312	60,71	1,1398	16,07
1,6217	59,82	1,1309	15,18+
1,6122	58,93	1,1208	14,28
1,6027	58,03	1,1129	13,39
1,5932	57,14	1,1011	12,50
1,5840	56,25	1,0955	11,60
1,5748	55,36+	1,0896	10,71
1,5656	54,46	1,0833	9,80
1,5564	53,57	1,0780	8,93+
1,5473	52,68	1,0725	8,03
1,5385	51,78	1,0666	7,14
1,5292	50,89	1,0610	6,25
1,5202	50,00	1,0555	5,35

In *Nitrous Acid* ... Tem
100 Parts Sp. Gravity.
1,5543
1,5295
1,5183
1.5070
1,4957
1,4844
1,4731
1,4719
1,4707
1,4695
1,4683
1,4671
1,4640
1,4611
1,4582
1,4553
1,4524
1,4471
1,4422
1,4373
1,4324
1,4275
1,4222
1,4171
1,4120
1,4069
1,4018
1,3975
1,3925
1,3875
1,3825
1,3775
1,3721
1,3671
1,3621
1,3571
1,3521
1,3468
1,3417

The Numbe
the Tables of
found by Expe
only by Analog

different Denſities, at the Temperature of 60°.

Acid of different Denſities, at Temperature of 60°.			
Real Acid.	100 Parts Sp. Gravity.	Real Acid.	
89,29	1,4666	44,64	
88,39	1,4427	43,75	
87,50	1,4189	42,86+	
86,61	1,4099	41,06	
85,71	1,4010	41,07	
84,82	1,3875	40,18	
83,93	1,3768*	39,28	
83,04+	1,3663	38,39	
82,14	1,3586	37,50	
81,25	1,3473	36,60	
80,36	1,3360	35,71	
79,46	1,3254	34,82	
78,57	1,3149	33,93	
77,68	1,3102	33,03	
76,79+	1,3056	32,14	
75,89	1,2951	31,25	
75,—	1,2847	30,35	
74,11	1,2757	29,46	
73,22	1,2668	28,57	
72,32	1,2589	27,68+	
71,43	1,2510	26,78	
70,54+	1,2415	25,89	
69,64	1,2320	25,—	
68,75	1,2210	24,10	
67,86	1,2101	23,21	
66,96	1,2009	22,32	
66,07	1,1918	21,43+	
65,18	1,1836	20,53	
64,28	1,1746	19,64	
63,39	1,1678	18,75	
62,50	1,1614	17,85	
61,61	1,1531	16,96	
60,71	1,1398	16,07	
59,82	1,1309	15,18+	
58,93	1,1208	14,28	
58,03	1,1129	13,39	
57,14	1,1011	12,50	
56,25	1,0955	11,60	
55,36+	1,0896	10,71	
54,46	1,0833	9,80	
53,57	1,0780	8,93+	
52,68	1,0725	8,03	
51,78	1,0666	7,14	
50,89	1,0610	6,25	
50,00	1,0555	5,35	

In *Nitrous Acid* of different Denſities, at the Temperature of 60°.			
100 Parts Sp. Gravity.	Real Acid.	100 Parts Sp. Gravity.	Real Acid.
1,5543	73,54	1,3364	41,91
1,5295	69,86	1,3315	41,18
1,5183	69,12	1,3264	40,44
1,5070	68,39	1,3212	39,71
1,4957	67,65	1,3160	38,97
1,4844	66,92	1,3108	38,34
1,4731	66,18	1,3056	37,50
1,4719	65,45	1,3004	36,77
1,4707	64,71	1,2911	36,03
1,4695	63,98+	1,2812	35,30+
1,4683	63,24	1,2795	34,56
1,4671	62,51	1,2779	33,82
1,4640	61,77	1,2687	33,09
1,4611	61,03	1,2586	32,35
1,4582	60,30	1,2500	31,62
1,4553	59,56	1,2464	30,88
1,4524	58,83	1,2419	30,15
1,4471	58,09	1,2374	29,41
1,4422	57,36	1,2291	28,68
1,4373	56,62	1,2209	27,94
1,4324	55,89	1,2180	27,21+
1,4275	55,15	1,2152	26,47
1,4222	54,12+	1,2033	25,74+
1,4171	53,68	1,2015	25,00
1,4120	52,94	1,1963	24,26
1,4069	52,21	1,1911	23,53
1,4018	51,47	1,1845	22,79
1,3975	50,74	1,1779	22,06
1,3925	50,00	1,1704	21,32
1,3875	49,27	1,1639	20,59
1,3825	48,53	1,1581	19,85
1,3775	47,80	1,1524	19,12
1,3721	47,06	1,1421	18,48
1,3671	46,33	1,1319	17,65+
1,3621	45,59	1,1284	16,91
1,3571	44,86+	1,1241	16,17
1,3521	44,12	1,1165	15,44
1,3468	43,38	1,1111	14,70
1,3417	42,65	1,1040	13,27

The Numbers above the Lines drawn acroſs the Tables of vitriolic and nitrous Acids were found by Experiments; thoſe under the Lines only by Analogy.

In *Marine Ac*… ferent Denſiti… Temperature…
100 Parts Sp. Gravity.
1,196
1,191
1,187
1,183
1,179
1,175
1,171
1,167
1,163
1,159
1,155
1,151
1,147
1,1414
1,1396
1,1358
1,1320
1,1282
1,1244
1,1206
1,1168
1,1120
1,1078
1,1036
1,0984
1,0942
1,0910
1,0868
1,0826
1,0784
1,0742
1,0630
1,0345
1,0169

l of different Denſities, at the
mperature of 60°.

Real Acid.	100 Parts Sp. Gravity.	Real Acid.
73,54	1,3364	41,91
69,86	1,3315	41,18
69,12	1,3264	40,44
68,39	1,3212	39,71
67,65	1,3160	38,97
66,92	1,3108	38,34
66,18	1,3056	37,50
65,45	1,3004	36,77
64,71	1,2911	36,03
63,98+	1,2812	35,30+
63,24	1,2795	34,56
62,51	1,2779	33,82
61,77	1,2687	33,09
61,03	1,2586	32,35
60,30	1,2500	31,62
59,56	1,2464	30,88
58,83	1,2419	30,15
58,09	1,2374	29,41
57,36	1,2291	28,68
56,62	1,2209	27,94
55,89	1,2180	27,21+
55,15	1,2152	26,47
54,12+	1,2033	25,74+
53,68	1,2015	25,00
52,94	1,1963	24,26
52,21	1,1911	23,53
51,47	1,1845	22,79
50,74	1,1779	22,06
50,00	1,1704	21,32
49,27	1,1639	20,59
48,53	1,1581	19,85
47,80	1,1524	19,12
47,06	1,1421	18,48
46,33	1,1319	17,65+
45,59	1,1284	16,91
44,86+	1,1241	16,17
44,12	1,1165	15,44
43,38	1,1111	14,70
42,65	1,1040	13,27

In *Marine Acid* of different Denſities, at the Temperature of 60°.

100 Parts Sp. Gravity.	Real Acid.
1,196	25,28
1,191	24,76
1,187	24,25
1,183	23,73
1,179	23,22
1,175	22,70
1,171	22,18
1,167	21,67
1,163	21,15
1,159	20,64
1,155	20,12
1,151	19,60
1,147	19,09
1,1414	18,57
1,1396	18,06
1,1358	17,54
1,1320	17,02
1,1282	16,51
1,1244	15,99
1,1206	15,48
1,1168	14,96
1,1120	14,44
1,1078	13,93
1,1036	13,41
1,0984	12,90
1,0942	12,38
1,0910	11,86
1,0868	11,35
1,0826	10,83
1,0784	10,32
1,0742	9,80
1,0630	8,25
1,0345	5,16
1,0169	2,58

ers above the Lines drawn acroſs
vitriolic and nitrous Acids were
riments; thoſe under the Lines
y.

of vitriolic Acid to Water de-
Ratio of the Square of the Quan-

1,8070	75,89	[illegible]	[illegible]	[illegible]
1,7959	75,—	1,2847	30,35	1,4524
1,7849	74,11	1,2757	29,46	1,4471
1,7738	73,22	1,2668	28,57	1,4422
1,7629	72,32	1,2589	27,68+	1,4373
1,7519	71,43	1,2510	26,78	1,4324
1,7416	70,54+	1,2415	25,89	1,4275
1,7312	69,64	1,2320	25,—	1,4222
1,7208	68,75	1,2210	24,10	1,4171
1,7104	67,86	1,2101	23,21	1,4120
1,7000	66,96	1,2009	22,32	1,4069
1,6899	66,07	1,1918	21,43+	1,4018
1,6800	65,18	1,1836	20,53	1,3975
1,6701	64,28	1,1746	19,64	1,3925
1,6602	63,39	1,1678	18,75	1,3875
1,6503	62,50	1,1614	17,85	1,3825
1,6407	61,61	1,1531	16,96	1,3775
1,6312	60,71	1,1398	16,07	1,3721
1,6217	59,82	1,1309	15,18+	1,3671
1,6122	58,93	1,1208	14,28	1,3621
1,6027	58,03	1,1129	13,39	1,3571
1,5932	57,14	1,1011	12,50	1,3521
1,5840	56,25	1,0955	11,60	1,3468
1,5748	55,36+	1,0896	10,71	1,3417
1,5656	54,46	1,0833	9,80	
1,5564	53,57	1,0780	8,93+	
1,5473	52,68	1,0725	8,03	
1,5385	51,78	1,0666	7,14	
1,5292	50,89	1,0610	6,25	
1,5202	50,00	1,0555	5,35	
1,5112	49,11+	1,0492	4,46	
1,5022	48,21	1,0450	3,57	
1,4933	47,32	1,0396	2,67	
1,4844	46,43	1,0343	1,78	
1,4755	45,53			

* The Sp. Gravity was 1,3741 in the former Table.

The Numbe
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found by Expe
only by Analog

The Affinity
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tity of Water u
and 197.

And so I beli
it is the *mean* A

Note. The standard Quantities of *Vitriolic* Acid were re
Nitrous, by multiplying them into 0,7354, and the *Marine* l
in my last Paper.

[illegible]	[illegible]	[illegible]	[illegible]
959	75,—	1,2847	30,35
849	74,11	1,2757	29,46
738	73,22	1,2668	28,57
629	72,32	1,2589	27,68+
519	71,43	1,2510	26,78
416	70,54+	1,2415	25,89
312	69,64	1,2320	25,—
208	68,75	1,2210	24,10
104	67,86	1,2101	23,21
000	66,96	1,2009	22,32
899	66,07	1,1918	21,43+
800	65,18	1,1836	20,53
701	64,28	1,1746	19,64
602	63,39	1,1678	18,75
503	62,50	1,1614	17,85
407	61,61	1,1531	16,96
312	60,71	1,1398	16,07
217	59,82	1,1309	15,18+
122	58,93	1,1208	14,28
027	58,03	1,1129	13,39
932	57,14	1,1011	12,50
840	56,25	1,0955	11,60
748	55,36+	1,0896	10,71
656	54,46	1,0833	9,80
564	53,57	1,0780	8,93+
473	52,68	1,0725	8,03
385	51,78	1,0666	7,14
292	50,89	1,0610	6,25
202	50,00	1,0555	5,35
112	49,11+	1,0492	4,46
022	48,21	1,0450	3,57
4933	47,32	1,0396	2,67
4844	46,43	1,0343	1,78
4755	45,53		

The Sp. Gravity was 1,3741 in the
er Table.

[illegible]	[illegible]	[illegible]	[illegible]
1,4524	58,83	1,2419	30,15
1,4471	58,09	1,2374	29,41
1,4422	57,36	1,2291	28,68
1,4373	56,62	1,2209	27,94
1,4324	55,89	1,2180	27,21+
1,4275	55,15	1,2152	26,47
1,4222	54,12+	1,2033	25,74+
1,4171	53,68	1,2015	25,00
1,4120	52,94	1,1963	24,26
1,4069	52,21	1,1911	23,53
1,4018	51,47	1,1845	22,79
1,3975	50,74	1,1779	22,06
1,3925	50,00	1,1704	21,32
1,3875	49,27	1,1639	20,59
1,3825	48,53	1,1581	19,85
1,3775	47,80	1,1524	19,12
1,3721	47,06	1,1421	18,48
1,3671	46,33	1,1319	17,65+
1,3621	45,59	1,1284	16,91
1,3571	44,86+	1,1241	16,17
1,3521	44,12	1,1165	15,44
1,3468	43,38	1,1111	14,70
1,3417	42,65	1,1040	13,27

The Numbers above the Lines drawn acrofs the Tables of vitriolic and nitrous Acids were found by Experiments; thofe under the Lines only by Analogy.

The Affinity of vitriolic Acid to Water decreafes in the Ratio of the Square of the Quantity of Water united to it. 23 Ann. Chy. 196 and 197.

And fo I believe it does to all other Subftances; it is the *mean* Affinity that is commonly given.

1,132
1,128
1,124
1,120
1,116
1,112
1,107
1,103
1,098
1,094
1,091
1,086
1,082
1,078
1,074
1,063
1,034
1,016

ote. The ftandard Quantities of *Vitriolic* Acid were reduced to *Real* by multiplying them into
ous, by multiplying them into 0,7354, and the *Marine* by multiplying them into 0,516, for the Rea
ny laft Paper.

Y—1

58,83	1,2419	30,15
58,09	1,2374	29,41
57,36	1,2291	28,68
56,62	1,2209	27,94
55,89	1,2180	27,21+
55,15	1,2152	26,47
54,12+	1,2033	25,74+
53,68	1,2015	25,00
52,94	1,1963	24,26
52,21	1,1911	23,53
51,47	1,1845	22,79
50,74	1,1779	22,06
50,00	1,1704	21,32
49,27	1,1639	20,59
48,53	1,1581	19,85
47,80	1,1524	19,12
47,06	1,1421	18,48
46,33	1,1319	17,65+
45,59	1,1284	16,91
44,86+	1,1241	16,17
44,12	1,1165	15,44
43,38	1,1111	14,70
42,65	1,1040	13,27

1,1320	17,02
1,1282	16,51
1,1244	15,99
1,1206	15,48
1,1168	14,96
1,1120	14,44
1,1078	13,93
1,1036	13,41
1,0984	12,90
1,0942	12,38
1,0910	11,86
1,0868	11,35
1,0826	10,83
1,0784	10,32
1,0742	9,80
1,0630	8,25
1,0345	5,16
1,0169	2,58

ers above the Lines drawn acrofs vitriolic and nitrous Acids were riments; thofe under the Lines y.

of vitriolic Acid to Water de- atio of the Square of the Quan- nited to it. 23 Ann. Chy. 196

eve it does to all other Subftances; ffinity that is commonly given.

educed to *Real* by multiplying them into 0,8929. of the by multiplying them into 0,516, for the Reafons mentioned

Y—1

Of the Alteration arising from Difference of Temperature.

To discover this alteration by experiment in each individual instance would be an endless task, hence I have selected only 3 cases with respect to the vitriolic acid, and 2 of the nitrous, and observed the changes in each at every 5 degrees above 60° unto temperature 70°, and at every 5 degrees below 60° unto temperature 50° nearly, these being the temperatures at which experiments are usually made.

Of the Vitriolic Acid.

Vitriolic acid	1,8360	at	temperature	60°
Becomes	1,8292	at	-	70°
	1,8317	at	-	65°
	1,8382	at	-	55°
	1,8403	at	-	50°
	1,8403	at	-	49°

hence we see that vitriolic acid, whose density at 60° is 1,8360, loses by *ascending* and gains by *descending* 0,00068 for every degree of temperature between 60° and 70° and 0,00043 nearly by each degree between 60° and 49°.

 Again

Again, vitriolic acid	1,7005	at	-	60°
Becomes	1,6969	at	-	70°
	1,6983	at	-	65°
	1,7037	at	-	55°
	1,7062	at	-	50°

hence vitriolic acid, which at 60° is 1,7005 gains or loſes 0,00036 nearly for every degree between 60° and 70°, and 0,00051 by every degree between 60° and 50°.

Laſtly, vitriolic acid	1,3888	at	-	60°
Becomes	1,3845	at	-	70°
	1,3866	at	-	65°
	1,3898	at	-	55°
	1,3926	at	-	49°

hence vitriolic acid, which at 60° is 1,3888 gains or loſes 0,00043 nearly by every degree between 60° and 70°, and 0,00034, nearly by every degree between 49° and 60°, between 49° and 50°, I perceived no difference.

Of the Alteration of Denſity from Difference of Temperature in Nitrous Acid.

Nitrous acid, which was	1,4279	at	-	60°
Became - -	1,4178	at	-	70°
	1,4225	at	-	65°

1,4304	at	-	55°
1,4336	at	-	50°
1,4357	at	-	45°

hence nitrous acid, which at 60° is 1,4279, gains or loſes 0,00101 nearly by every degree between 60° and 70°; and 0,00052 by every degree between 45° and 60°.

I formerly found that the ſtrongeſt *ſpirit of nitre* is moſt expanded by heat or contracted by cold.

ALSO, that nitrous acid, whoſe ſp. grav. at 34° was 1,4750, was expanded by heat as follows:

	1,4750	at	34	then it gains or loſes 0,0097 by 15°
became	1,4653	at	49	between 34° and 49° incluſively.

Again I found that colourleſs nitrous acid whoſe ſp. grav. was

		1,4650	at	-	30°
became	-	1,4587	at	-	46°
		1,4302	at	-	86°

hence by the firſt 16° from 30° to 46° it gained 0,0063, and by 40°, that is from 46 to 86°, it gained 0,0285.

Again, nitrous acid whoſe denſity was

		1,2363	at	-	60°
became	-	1,2320	at	-	70°
		1,2342	at	-	65°

1,2384	at	-	55°
1,2406	at	-	50°
1,2417	at	-	45°

hence nitrous acid, which at 60° is 1,2363, gains or loſes by every degree between 60° and 70°, 0,00043 and 0,00036 by every degree between 60° and 45°; and we may aſſume 0,0005 as the variation incident to every degree between 60° and 70° in nitrous acid, whoſe denſity at 60° is between 1,3 and 1,4 and 0,0004 for the variation between 44° and 60°

Of Marine Acid.

I formerly found that this acid of the denſity 1,196 at 33° became of the denſity 1,1820 at 66°, the alterations of acids of lower ſp. grav. I have not examined, but I found that in general its dilatability is greater than that of nitrous acid of the ſame denſity.

OF THE USE OF THESE TABLES.

PROBLEM 1ſt.

AN *extratabular* ſpecific gravity being given, but intermediate between ſome of thoſe in the table, to *find the quantity of real acid* in 100 parts of ſuch acid liquor.

1ſt.

1ſt. Find the difference betwixt the next higher and lower tabular denſities = D, and alſo the difference betwixt their acid contents = D′.

2d. Find the difference betwixt the *extratabular* ſp. gravity and the next upper or next lower, which ever it is neareſt to = *d*, and let the difference betwixt its acid contents (or quantity of real acid) and thoſe of the next upper or lower = *d′*, which is the quantity ſought; then as D. D′ : : *d*. *d′* then $d' = \frac{D'\,d}{D}$ conſequently *d′* added to the acid contents of the lower tabular ſp. grav. or ſubſtracted from the upper, *is the quantity ſought.*

Note. In general when *d*, that is the difference between the extratabular ſp. grav. and any tabular ſp. grav. does not exceed $\frac{2}{1000}$ it is inſenſible, and the acid contents of the lower or upper, which ever is neareſt, may be aſcribed to it.

Problem 2d.

The *quantity of real acid* in 100 parts of an acid liquor being given but *extratabular*, being intermediate between ſome of the quantities in the tables, *to find the ſp. grav. of* ſuch acid liquor.

Find D, D′ and *d′* as in the foregoing problem. then $d = \frac{D\,d'}{D'}$ then *d* added to the lower tabular ſp. grav. or ſubſtracted from the upper, gives the ſp. grav. ſought.

But

But with regard to the *marine acid* its ſp. grav. is to be inveſtigated according to the ordinary mathematical rules.

Problem 3d.

To find how much water muſt be added to 100 parts of an acid liquor of a given ſp. grav. to bring it down to another lower given ſp. grav.

1ſt. Find by the table the quantities of acid and water in 100 parts of each of the acid liquors reſpectively, each being ſuppoſed to be in the table, let the quantity of water in the denſer be W, and the quantity of acid $= A$, let the quantity of water in the leſs denſe $= w$, and the quantity of acid $= a$, and the quantity of water to be added to 100 parts of the denſer $= m$

then $W + m$ muſt be to A as w to a

And $W a + a m = A w$. And $a m = A w - W a$.

And $m = \dfrac{A w - W a}{a}$

Problem 4th.

Given weights of 2 *or more acid liquors* of different ſp. gravities being mixed, to find the quantity of real acid in 100 parts of the mixt liquor and its ſp. grav.

Find

FIND the ſum of the quantities of real acid in 100 parts of the mixture, then find the reſulting ſp. grav. by the 2d problem, if the given ſp. gravities be extratabular, the operation muſt be more tedious, as the acid contents of each muſt be found.

PROBLEM 5th.

THE quantity of an acid liquor requiſite to ſaturate 100 *parts* of *any baſis* being found, to find the ſp. grav. of that acid liquor.

1ſt. FIND by the 4th table the quantity of real acid requiſite to ſaturate 100 *parts* of the given baſis, it is then plain that the *given* quantity of acid liquor contains the requiſite quantity of *real acid*, ſince it is ſuppoſed to ſaturate 100 parts of the baſis and hence we may ſee how much 100 parts of ſuch acid liquor contains of *real acid*, and if this laſt found quantity be in the table, its ſp. grav. will be ſeen, but if extratabular, its ſp. grav. muſt be ſought by the 2d problem.

PROBLEM 6th.

THE quantity of real acid requiſite to ſaturate 100 parts of any baſis being known, to find how much of one acid liquor of any given ſp. grav. is requiſite to ſaturate that, and conſequently any other given quantity of ſuch baſis.

If

If the given ſp. grav. of the acid liquor be *tabular* the quantity of real acid in 100 parts of it is apparent, and conſequently the quantity of ſuch acid liquor containing the required quantity of real acid, is caſily found by the rule of proportion. But if the given ſp. grav. is *extratabular* the quantity of real acid in 100 parts of the acid liquor muſt be ſought by the firſt problem.

Problem 7th.

The quantity of real acid, in a given quantity of an acid liquor being known, and alſo the quantity requiſite to ſaturate 100 parts of any given baſis. To diſcover the quantity of ſuch baſis contained in any ſolution, or in any powder, by which the given quantity of acid liquor is ſaturated.

If the baſis be ſingle (that is unmixed with any other baſis to which the acid may unite) or combined only with fixed air the ſolution is eaſy, but if the given baſes be mixed with other baſes combinable with the ſame acid, the ſolution is more complex and varies according to the variety of caſes.

Problem 8th.

To find how much of an acid liquor of *one ſort* will hold as much *real acid*, as is held by a given weight of an acid liquor of *another ſort* whoſe ſp. grav. is alſo given :—For inſtance, how much vitriolic acid will contain the ſame quantity of real acid as is contained in 100 grains nitric acid whoſe ſp. grav. is 1,3925.

1ſt. Firſt find by the table the quantity of real acid contained in the given quantity of the ſecond acid, whoſe ſp. gr. is given, or if not in the table it muſt be found by Problem 1ſt.

2d. It is apparent that the quantity of the firſt acid liquor muſt vary with its ſp. gr. thus, in the inſtance given, as 100 parts nitrous acid of the ſp. grav. 1392 contains 50 parts real nitrous acid, ſo 100 parts vitriolic acid whoſe ſp. grav. is 1,5202 contains by the table the ſame quantity of real acid, *v. z.* 50 parts, but of the vitriolic acid whoſe ſp. grav. is 1,800 only 64 parts are requiſite to contain 50 parts of real acid, whereas 200 grains are requiſite of the vitriolic acid whoſe ſp. grav. is 1.2320.

Note, The ſolution of this problem may hereafter be found of uſe in comparing the quantities and affinities of oxygen in different acids.

PROBLEM 9th.

To find the ſp. grav. of ſuch vitriolic acid as that 100 parts of it ſhall contain the ſame quantity of real acid as 100 parts of the nitrous.

THIS can be found only by *inſpection* on conſulting the tables; an example has been ſeen in the laſt problem, ſo alſo 100 parts vitriolic acid 1,3102 contain the ſame quantity of real acid as 100 parts nitrous acid whoſe ſp. gr. is 1,2687. And 100 grains vitriolic acid whoſe ſp. gr. is 1,1746 contains the

ſame quantity of real acid as 100 grains ſp. ſalt whoſe ſp. gr. is 1,159.

AND, 100 grains nitrous acid 1,1963 contains the ſame quantity of real acid as 100 grains ſpirit of ſalt whoſe ſp. grav. is 1,187.

HENCE it ſhould ſeem that the ſp. grav. of the *real marine acid* is ſmaller than that of the *real nitrous*, and that of the real nitrous ſmaller than that of the *real vitriolic*, ſince when the weight of each acid, and alſo the weight of real acid in each is equal, the vitriolic acid is ſpecifically heavier than the nitrous, and the nitrous than the marine, but this perhaps may ariſe from penetration.

PROBLEM 10.

To find how much of a neutral ſalt of one ſort holds as much real acid or baſis as a given weight of the *ſame* neutral ſalt in another ſtate, or as a given weight of *another* ſalt in any given ſtate.

THESE queſtions are reſolved by the 4th and 5th tables, thus if it be aſked, how much nitre contains as much acid as 20 grains of vitriolated tartarin? By the 4th table I ſee that 221,48 parts of vitriolated tartarin and 227,22 parts nitre contain equal quantities of acid ſince both contain 100 parts, then as 221,48. 227,22 : : 20.20,5.

AGAIN,

Again, How much deficcated foda will hold as much alkali as 30 parts cryftallized foda? In the 5th table I fee that 541,1 parts of the cryftallized hold as much alkali as 227,4 parts of the deficcated, then as 541,1 . 227,4 : : 30 . 12,6.

Problem 11th.

How much of a given bafis will be requifite to faturate the acid contained in a given quantity of a given neutral falt, thus how much deficcated foda will be requifite to faturate the acid contained in 50 parts cryftallized Epfom?

By the 4th table I fee that 100 parts real vitriolic acid are contained in 340 parts cryftallized Epfom. Then if 340.100 : : 50, 14,7, then by the 3d table I fee that 100 grains of real vitriolic acid faturate 78,32 of foda. Confequently if 100 faturate 78,32 : : 14,7 would faturate 11,51 of foda.

Laftly, In the 6th table I find that 100 grains deficcated foda contains 60 of foda. Then if 100 : 60 : : x. 11,51, then $x = 19,1$ parts deficcated foda. Then 19,1 parts deficcated foda will faturate the acid contained in 50 parts cryftallized Epfom.

Note 1ft. This problem is of ufe in determining the quantity of any precipitating fubftances to be employed in decompofitions,

 operated

operated either by a ſingle or double affinity. But in moſt caſes *more* of the precipitant muſt be employed than the exact quantity neceſſary for ſaturation, and particularly when decompoſitions are attempted in the dry way, as otherwiſe a complete contact with the ſubſtance to be decompoſed will not be attained, or if volatile it may be ſublimed before the decompoſition takes place.

PROBLEM 12th.

SOME analyſts have denoted the ſtrength of their acids by expreſſing the quantities of each neceſſary to ſaturate a *certain quantity* of alkaline liquor (and ſometimes of another baſis) without even telling whether the alkali was mild or cauſtic, or the quantity of it contained in the alkaline liquor. This problem is conſequently indeterminate. However a method of giving ſome ſolutions of it may be underſtood from the following example; and circumſtances will generally ſhew whether the application to particular caſes be juſt.

Link tells us that 240 grains of a vitriolic acid which he employed, ſaturated 6,5 times its weight of tartarin (he muſt mean in a liquid ſtate, as no vitriolic acid will ſaturate ſix times its weight of real alkali) and that 240 grains of the nitrous acid he employed ſaturated 2.5 times its weight of the ſame alkali. *Quere* the ſpec. gravity of both acids?

1ſt IT is plain, that ſince 240 grs. of the nitrous acid ſaturated 2,5 times its weight of the alkali, 624 grs. of that acid would ſaturate

turate 6,5 times its weight of the alkali; and fince 624 grs. of the nitrous acid would faturate as much alkali as 240 of the vitriolic acid, then 260 grs. of it would faturate as much alkali as 100 grs. of the vitriolic acid could faturate. Therefore fuppofing 100 of the vitriolic acid to contain 75 of real acid, fince more real nitrous acid is required to faturate a given quantity of tartarin than of vitriolic acid, in the inverfe ratio of 1214 to 1177 (as appears by the third table,) then denoting the quantity of real nitrous acid in 260 grs. of the nitrous liquor, by x we have the following equation as $1214 . 1177 :: x \; 75$. and $x = 77{,}55$. Then 260 grs. of the nitrous acid contain 77,55 of real nitrous acid, confequently 100. grs. of it contained 29,82 real acid. And therefore its fp. grav. was nearly 1,234, and that of the vitriolic about 1,800.——The quantity of alkali in the alkaline liquor might alfo on this fuppofition be determined.

So if it be required to know how much common falt is requifite to decompofe a folution of nitrated filver containing 176,25 grs. of filver:

1ft. I find by the 6th table that 75 grs. filver take 16,54 of marine acid, confequently 176,25 gr. filver take up 38,87.

2d. By the 4th table, I find that 100 grs. muriatic acid are contained in 257,2 of common falt, confequently 38,87 are contained in 99,973, that is 100 grs. common falt, then 100 grs. of it are neceffary to precipitate the filver.

ILLUSTRATION

ILLUSTRATION OF THE TABLES.

FEW chymifts have made experiments appofite to my prefent purpofe, and thofe that have made any relative to it, have generally neglected marking the temperature, and thus prevented an exact comparifon of the refults they obtained with thofe that fhould be expected from the quantities of real acid and water fet forth in my tables.

THE moft accurate of thefe experimenters was Hahn, who has inftituted a confiderable number, of which an account is given in his Differtation *De Efficacia Mixtionis in Mutandis Corporum Voluminibus*; of thefe I fhall felect a few, which I think by their coincidence with the refults to be obtained, calculating from my tables, furnifh a full proof of their accuracy, at leaft to as great a degree as can be expected in fubjects of this nature.

OF THE TABLE OF VITRIOLIC ACID.

1ft Experiment.

HAHN, to 800 grs. of vitriolic acid whofe fp. grav. was 1,8489 at the temperature of 44°, added 400 grs. of water in a veffel that confined the vapours, and when the mixture was cooled down to the temperature of the air he found its fp. grav. 1,545.—p. 48 and 49.

Application.

Application.

VITRIOLIC acid of this denſity loſes, as we have ſeen, ,00043 in denſity, by each degree between 44° and 60°; hence its ſp. grav. at 60° ſhould be 1,8489 —,00043 × 16 = 0,0068 = 1,8421, which differs inſenſibly from the next lower tabular ſp. grav. 1,8424, and therefore this may be taken for it.

THE quantity of real acid in 100 grs. of the acid liquor, whoſe ſp. grav. is 1,8424 amounts to 78,57 per cent. *per table*, then 800 grs. of that acid liquor contains 78,57 × 8 = 628,56 of real acid, and conſequently the 1200 gr. of the mixture contain that quantity of real acid, and therefore 100 grs. of the mixed liquor contain 52,38 of real acid, which we ſee differs but little from the *tabular real acid*, 52,68 which indicates the ſp. grav. to be 1,5473, and the difference between this and the ſp. grav. found by Hahn is inconſiderable.

HOWEVER, to obtain a cloſer approximation, and to give an example of the mode of ſolving the 2d problem, I ſhall deduce the ſp. grav. from the rules laid down for the ſolution of that problem.

1ſt. THE next higher ſp. grav. is 1,5473, and the next lower is 1,5385, and the difference between them is 0,0088 = D.
Their acid contents are 52,68 and 51,78, and their difference 0,9 = D′.

2d.

2d. THE difference betwixt the given extratabular acid contents, 52,38, and the next lower tabular acid contents 51,78 is 0,6 = d' then d, the quantity to be added to the lower ſp. grav. is found by the formula $d = \frac{D\,d'}{D'} = \frac{0{,}0088 \times 0{,}6}{0{,}9} = \frac{0{,}0528}{0{,}9} = 0{,}0058$

$$\begin{array}{rl} & 1{,}5385 \\ \text{Now} + & \underline{0{,}0058} \\ = & 1{,}5443 \end{array}$$ and that found by Hahn is 1,545.

THIS it is true would be the ſp. grav. at 60°, and after 3 days reſt (the time I allowed for the penetration of the mixtures mentioned in my tables,) and it does not appear what the temperature of Hahn's mixture was when he took its ſp. grav. if it was 44° (the temperature of his oil of vitriol) it is poſſible that the cold without exact penetration might produce an effect equivalent to that which time would produce by penetration.

2d Experiment.

IN this Hahn added 400 grs. of water to the 1200 grs. of the foregoing mixture, and conſequently the new mixture weighed 1600 grs. and contained the ſame quantity of real acid as the foregoing, that is 628,56 grs. he found its ſp. grav. when cold to be 1,38,40.

Application

Application.

SINCE 1600 grs. of the mixture contained 628,56 real acid, 100 grs. of it ſhould contain 39,28; now this quantity of real acid is exactly in the table, and correſponds with the ſp. grav. 1,3768. Then the difference between Hahn's reſult and that of my determinations is $\frac{72}{10000}$.

3d Experiment.

TO the 1600 grs. of the laſt mixture Hahn added 800 of water, and when the whole was cooled down to the temperature of the air he found the ſp. grav. of the mixture 1,2439. Ibid. p. 50.

Application.

THIS mixture weighed 2400 grs. and contained the ſame quantity of real acid as the laſt, namely, 628,56 grs. conſequently 100 grs. of it contained 26,19; this quantity of real acid is extratabular; the neareſt tabular quantity of real acid is 25,89, which correſponds with the ſp. grav. 1,2415; though this ſeems ſufficiently near to Hahn's reſult, yet I have found it more exactly by the 2d problem. Here $D = 0{,}0095$ and $D' = 0{,}89$ and $d' = 0{,}3$, then by the formula $d = \frac{D\,d'}{D'}$ we have $\frac{0{,}0095 \times 0{,}3}{0{,}89} = 0{,}0032$, and the lower ſp. grav. $1{,}2415 + 0{,}0032 = 1{,}2448$, which differs from Hahn's reſult by only $\frac{9}{10000}$.

The 3 firſt experiments of Hahn not perfectly agreeing with each other, and not having been made with equal accuracy, I omit.

Morveau's Experiment on the Quantity of Real Acid in Vitriolic Acid, whoſe Sp. Grav. was 1,841. 1 *Encyclop.* 592.

He took 58 grs. vitriolic acid, whoſe ſp. grav. at 8°,5 Reaum. (= 51° Fahr.) was 1,841, and poured into it a ſolution of acetited barytes until a precipitate ceaſed to appear. The precipitate waſhed and dried (by ignition as it would ſeem by what he adds in the 2d column of the above page) weighed 110,3 grs.

Application.

Vitriolic acid, whoſe ſp. grav. at 51° of Fahr. is 1,841, would have its ſp. grav. lowered to 1,838 at 60° of Fahr. the degree for which my tables were formed, as I have ſhewn in my remarks on the alteration by temperature.

Now the ſp. grav. 1,838 is intermediate between the tabular denſities 1.8306 and 1,8424, but nearer to this; then by the firſt problem its acid contents will be found to be 78,24 per cent. then if 100 grs. of vitriolic acid of this ſp. grav. contain 78,24 per cent. real acid, 58 ſhould contain 45,37 of real acid. But 110,3 grs. of ignited barytes contain 36,76 real acid, allowing 100 grs. of ſuch barytes to contain 33,33 per cent. the difference then between

tween Mr. Morveau's refult and that of my calculation is 8.61 grs.; the reafon, however, is obvious; Morveau employed acetited barytes, this acid rendered part of the acid fulphureous, as is well known; the fulphureous acid does not decompofe acetited barytes per Bergman's table, his other experiments on the fulphureous acid cannot therefore apply.

Of the Table of Nitrous Acid.

Though this acid was not exactly oxyginated and colourlefs, yet it was far from being fully de-oxyginated, but in that pale red ftate in which it commonly appears; what changes the variety of oxyginations may produce I have not experienced; the refults are not quite fo accurate as moft of thofe in the table of vitriolic acid, partly from the eruption of vapour during the weighing, and partly from the diforder the fumes caufe at long run in the fcales; but the error in the quantity of real acid in 100 parts of the acid liquor, no where, as far as I have had occafion to examine, amounts to 1 per cent. or at leaft does not exceed that amount; the lower part of the table I found moft faulty, and have rectified the errors to a great degree.

Experiment 1ft.

To 400 grs. of nitrous acid, whofe fp. grav. at 63° was 1.4905, Hahn added 200 of water, and when the whole was cooled down to 64° he found the fp. grav. to be 1.3157.

 Application.

Application.

The ſp. grav. 1,4995 at 63° would be (by the table of variation already ſeen) 1,4995 + 00101 × 3 = 1,5025, which ſcarcely differs from 1,5070, a tabular number, which denotes the acid contents 68,39 — and if 100 grs. of this acid liquor contain 68,39 real acid, 400 grs. contain 68,39 × 4 = 273,56, and when 200 grs. of water were added, then 600 grs. contained 273,56, and conſequently 100 grs. of the mixture contained 45,59, which indicates the tabular ſp. grav. 1,3621, which at the temperature of 64° would be 1,3581.

THIS denſity differs much from that found by Hahn, being $\frac{42}{1000}$, but that the error proceeds from his not having allowed ſufficient time for the penetration of the water and acid, and from the loſs of acid by the heat excited will be ſeen in the examination of the 2d experiment.

Experiment 2d.

To the 600 grs. of the mixture of the laſt experiment, whoſe ſp. grav. was by him 1,3157, and at 60° would be 1,317, he added 200 grs. of water, and found the ſp. grav. of this laſt mixture at 64°, 1,2561, which at 60° would be 1,2578, the heat excited amounted to 80°.

Application.

Application.

THE ſp. grav. 1,317 differs inſenſibly from 1,316, which indicates the acidity 38,97 per cent. and if 100 grains contain 38,97 : : 600 ſhould contain 233,82 (whereas we have already ſeen that 600 contains 273,56) and when 200 grains more of water were added, then 800 ſhould contain 233,82, and conſequently 100 ſhould contain 29,22 real acid, which indicates very nearly the ſp. grav. of this 2d mixture to be 1,237, which differs from Hahn's reſult by $\frac{\begin{array}{r}1,257\\-1,237\end{array}}{0,020}$ by $\frac{20}{1000}$, a difference which, though conſiderable, is by the half ſmaller than that of the 1ſt experiment, as by the interval of time between the 1ſt and 2d experiment the penetration of the 200 grains of water firſt added had increaſed.

THIS calculation is grounded on Hahn's reſults, which are erroneous from want of reſt and the eſcape of vapours. We ſhall now ſee what the ſp. grav. of this laſt mixture ſhould be, if both this and the former experiment were more accurately conducted, and the water ſo gradually added that little or no heat would be generated, on which principle my former calculation proceeded. This experiment may be conſidered as a mixture of 600 grains of an acid liquor, whoſe ſp. grav. ſhould, by my table, be 1,3621, and whoſe acid contents are 273,54 grains with 200 grains of water, and then

800

800 grains (the quantity of this 2d mixture) muſt contain 273,54 grains of real acid, and conſequently 100 grains of this new mixture contains 34,19 grains real acid, which indicates very near the ſp. grav. 1,2779, which differs from Hahn's reſult by $\frac{20}{1000}$, being ſo much higher.

But this ſame experiment may alſo be conſidered as a mixture of 400 grains of the ſtrong acid 1,5025 with 400 grains of water, then as the 400 grains acid liquor contains 273,56 grains real acid as already ſaid, 800 grains of the mixture ſhould contain the ſame quantity of real acid, and the ſame ſp. grav. would be found to reſult as above.

Experiment 3d.

In this experiment he added 2 parts water (ſuppoſe 200 grains) to 1 part of the ſp. of nitre 1,5025, much heat and copious red vapours were produced, inſomuch that a few grains of the weight of the whole were loſt (about 3 per cent.) and the ſp. grav. was 1,1723, the temperature is not mentioned, but it ſeems probable it was 64°, the temperature at which, he ſays, the mixture was made, then at 60° it would be 1,1740.

Application.

Here the 300 grains of mixed acid liquor contained 68.39 real acid, then 100 grains of it would contain 22,79, which is in the table, and indicates the ſp. grav. 1,1845, which exceeds Hahn's reſult

refult by $\frac{12}{1000}$, a difference which evidently arifes partly from the efcape of the red vapours and partly from want of fufficient time for penetration; it fhould however be remarked, that in large veffels there may fometimes be an increafe of weight from the abforption of oxygen by the nitrous air expelled by the generated heat.

Experiment 4th.

Mr. Richter (Stochymetrie, 3 theile, p. 9.) mixed fpirit of nitre, whofe fp. grav. was 1,5304 with water, in the proportion of 100 parts of the acid with 342 of water, and found the fp. grav. of the mixture 1,123; the temperature is not mentioned.

Application.

100 grains nitrous acid 1,530 contains by my table about 70 grains real acid, and when mixed with 342 of water, 442 grains will then contain 70 real acid, and confequently 100 grains of the mixture will contain 15,83 of real acid, this quantity lies between the tabular acidities 16,17, and 15,44, and by the 2d problem it will be found to correfpond with the fp. grav. 1,120.

Of

OF THE MARINE ACID.

THE mixtures of this acid and water are attended with little or no heat, and the ſp. gravities are ſuch as may be found by calculation. See 33 Roz. 242. Mr. Berthollet, among his experiments on oxyginated muriatic acid, Mem. Par. 1785, relates that having precipitated a ſolution of nitrated ſilver with 500 grains of common muriatic acid, whoſe ſp. grav. was 1,141, he obtained 547 grains of muriated ſilver, conſequently 100 grains of this acid would have afforded 109,4 of muriated ſilver. Now, as we ſhall hereafter ſee, 100 grains of muriated ſilver contain 16,54 of real marine acid, therefore 109,4 grains of muriated ſilver ſhould contain 18,02; and by my table 100 grains of the muriatic acid 1,1414 contains 18,57 of real acid.

CHAP. II.

ILLUSTRATION OF THE PROPORTION OF INGREDIENTS IN VITRIOLIC NEUTRAL SALTS.

BEFORE I treat of theſe ſalts it will be proper to notice the ſtate of each of their baſes.

OF VEGETABLE ALKALI OR TARTARIN.

THIS alkali may be obtained in three ſtates, the fully aerated and cryſtallized, the imperfectly aerated or common mild tartarin, and the cauſtic, which may alſo by particular proceſſes be cryſtallized.

THE fully aerated and cryſtallized contains, by Mr. Pelletier, 41 per cent. of alkali, 43 fixed air, and 16 water, 15 An. Chym. note, however, that even the cryſtallized is not always fully aerated, 1. Bergman, 16, 17.

COMMON dry ſalt of tartar contains about 60 per cent. of alkali, 28 or 30 of fixed air, with a few grains of Silex, vitriolated tartarin and argill; common pot-aſh generally contains alſo ſome grains of vitriolated and muriated tartarin.

Section 1st.

VITRIOLATED TARTARIN.

By my determinations, 86 grains purified and dry tartarin * were saturated by 130 grains of vitriolic acid, whose sp. grav. at 60° was 1,565.

Now this sp. grav. indicates by the table 54,46 real acid; consequently 130 grains of it contained 70,79 real acid, and 86 tartarin + 70,79 real acid = 156,79 vitriolated tartarin.

Hence 100 parts tartarin take up 82,48 of real vitriolic acid. And 100 parts real vitriolic acid take up 121,48 of tartarin. And 100 grains tartar vitriolate contain 54,8 tartarin, and 45,2 of real vitriolic acid; or in round numbers 55 tartarin, and 45 real acid; or in the proportion of 11 to 9.

Experiment of Dr. Black.

Since the publication of the above mentioned determinations, the highly delicate and accurate experiments of Dr. Black, undertaken with the view of ascertaining the contents of the Geyser waters have appeared, with one of which I have compared the foregoing

* By tartarin the mere caustic state is indicated; when it contains fixed air I call it mild; or fully aerated, if it be saturated therewith.

foregoing determinations, and had the pleaſure of finding an almoſt perfect coincidence See 3 Edinb. Tranſ. p. 101, 102. Dr. Black to vitriolic acid whoſe ſp. grav at 60° was 1,798, added 100 times its weight of water, and found that 112 grs. of this dilute acid ſaturated exactly 1 gr. of tartarin.

Application.

To exclude fractions I ſhall multiply Dr. Black's quantities by 100; then if 200 grains of vitriolic acid 1,798 were diluted with 20000 grains of water, his dilute acid would conſiſt of 20200 grains, 11200 of ſuch dilute acid would ſaturate 100 grains of tartarin. Now vitriolic acid 1,798 differs inſenſibly from 1,7959 which by my table contains 75 grains per cent. real acid. Therefore 11200 grains of ſuch acid ſo diluted would contain 83,16 real acid, which differs from my determinations only by $\frac{68}{100}$ of a grain. $83,16 - 82,48 = 0,68$.

Hence we may find the ſp. gravity and quantity of real acid in the ſp. of vitriol employed by Wenzel, which it will be uſeful to know as he made ſeveral intereſting experiments; and thus alſo the accuracy of the table of vitriolic acid will be ſtill farther confirmed.

For this inveſtigation he has furniſhed us with two *data*; 1ſt, he tells us that his ſp. of vitriol was formed of two parts of

Bb 2 highly

highly concentrated vitriolic acid and three parts water, and 2dly, that 240 grains of this ſp. contained 75,75 of ſuch acid as is found in ignited tartar vitriolate which is what I call real acid.

WHENCE I deduce that $\frac{2}{5}$ of his ſp. of vitriol conſiſted of the highly concentrated acid, and $\frac{3}{5}$ of water. Now $240 \times \frac{2}{5} = 96$, therefore 96 grains of the concentrated acid contained 75,75 of real acid, then 100 grs. of it would contain 78,9, which quantity belongs to a ſp grav. intermediate between the tabular denſities 1,8542 and 1,8424, and by the ſecond problem will be found to be 1,8467, therefore when one part of it is mixed with 1½ of water, or for inſtance, when 100 grains of it are mixed with 150 of water, (which is the ſame as mixing two parts with three) the compound amounting to 250 grains contain 78,9 real acid, and 100 grains of this dilute acid contain 31,56 of real acid, a quantity which is extratabular, but belongs to a ſp grav. which by the ſecond problem will be found to be 1,2987.

THEREFORE the ſp. grav. of Wenzel's oil of vitriol is 1,8467 containing 78,9 real acid per cent. and the ſp grav. of his ſpirit of vitriol was 1,2987, containing 31,56 per cent real acid.—261,976 (262 grs.) of his ſpirit of vitriol would ſaturate 100 grs. of tartarin.

1000 grains of Dr. Black's dilute vitriolic acid contained 7,425 real acid. As I found it has lately been denied that vitriolated tartarin

tartarin contained 45 per cent. real vitriolic acid, I diſſolved 100 grains of it in ſix ounces of water, and precipitated the acid by muriated barytes, the reſulting baroſelenite weighed after ignition 135,25, which proves as we ſhall ſhall preſently ſee that the vitriolated tartarin contained 45,078 grains of real acid.

Section 3d.

OF SODA AND VITRIOLATED SODA, OR GLAUBER.

As ſoda may be had either chryſtallized, effloreſced or deſiccated, it will be neceſſary to examine the proportion of real alkali in each, in order to find the proportion in neutralized compounds.

1ſt. IN its cryſtaliized ſtate even when recently formed, I found the proportion of its ingredients ſomewhat variable, b ut in the greater number of experiments the cryſtals being dried in filtering paper in a temperature not above 66°, and the air not much diſpoſed to give out moiſture. I found 100 parts of the cryſtals to contain 64 of water, 21,58 of real ſoda, and 14,42 of fixed air. 36 Grains therefore of aerated but deſiccated ſoda are equal to 100 grains of the cryſtallized, that is, contain the ſame quantity of alkali.

2dly

2dly, In its simply effloresced state the quantities are variable according to the more or less perfect efflorescence, the state and temperature of the air.

3dly, 100 parts *soda fully aerated but thoroughly desiccated* in a heat somewhat below ignition contains 59,86 alkali or mere soda, and 40,05 of fixed air per cent. or nearly 60 of alkali, and 40 of fixed air. In the experiments in my former paper the soda was heated to ignition, and thus part of the fixed air was probably expelled, for I found only 36 per cent. of fixed air.

Of Glauber.*

By my determinations, 100 *parts of soda* (that is, mere soda, dry and free from fixed air) are saturated by 127,68 of real vitriolic acid. And 100 parts of real vitriolic acid are saturated by 78,32 of soda. Hence if Glauber contained *no water*, 100 parts of it would contain 43 92 of soda and 56,08 of real vitriolic acid, or nearly 44 *soda* and 56 *real acid*; and this is the state of glauber thoroughly desiccated.

But *crystallized Glauber* contains a large proportion of water, for 100 parts of it *lose* 58 by a heat somewhat below ignition, therefore 42 parts only remain which contain alkali and acid in the proportion above mentioned of 44 to 56, that is, 18,48 of alkali and 23,52 of acid.

* This salt being long known by the name of Glauber's salt, I shall simply call Glauber, this being shorter, and serving as a memorial of the antient denomination. It claims by the same (but a much elder) title, as *Scheelium* and *Witherite*.

Hence 1ſt. 42 grains of deſiccated Glauber are equivalent to 100 of the cryſtallized.

Hence 2dly, 100 grains deſiccated Glauber ſhould give, or are equivalent to, 238 of the cryſtallized, that is, they contain the ſame quantity of alkali and acid as 238 of the cryſtallized.

Hence 3dly, 100 grains of ſoda ſaturated with vitriolic acid ſhould give 541 + of cryſtallized Glauber, or 227 of deſiccated Glauber, and 100 parts cryſtallized ſoda ſhould give 116,77 of cryſtallized Glauber; or 49 deſiccated Glauber, and 100 grains real vitriolic acid ſhould give when ſaturated with ſoda (whether cryſtallized or not) 425 + of cryſtallized Glauber or 178,5 of deſiccated.

But theſe quantities of deſiccated or cryſtallized ſalt are never *exactly* obtained, on account of the loſs by evaporation, and of what remains in the mother liquor.

Application.

On the Proportions in aerated Soda.

Experiment 1ſt. Dr. Black's. 3 Edinb. Tranſ. 106.

His quantities being fractionary to render the calculation clearer, I multiply all into 1000.

He

He found 2380 grains cryſtallized ſoda to contain 514 of mere cauſtic alkali, then 100 ſhould contain 21,17 of alkali, which differs from my reſult by leſs than ½ a grain. Hence 21,17 grains of mere ſoda are equivalent to 100 grains of the cryſtallized.

Again, he found that 2380 grains of cryſtallized ſoda loſe by thorough deſiccation 1523 grains, and conſequently are reduced to 857 grains, therefore 100 grains of the cryſtallized are reduced to, and are equivalent, as to real alkaline contents, to 36 grains, loſing therefore 64 grains of mere water.

And, laſtly, he found that 857 grains of deſiccated ſoda contain 514 of mere cauſtic ſoda, and conſequently 100 grains of the deſiccated contain nearly 60 of mere ſoda, and conſequently 40 of fixed air. All theſe reſults agree almoſt exactly with mine.

Experiment 2d. 1 Klaproth, 333.

In his experiment 1000 grains of dry cryſtallized ſoda loſt when thoroughly deſiccated in a ſand-heat, 637 grains of water, conſequently 100 ſhould loſe 63,7, which ſcarcely differs from Dr. Black's reſult, then the dry reſiduum amounts to 36,3 grains.

Of

Of the Proportions in Glauber.

1st Experiment. Dr. Black's, 3 Ed. Tranf. 106.

514 grains of mere foda were faturated by 88180 of the dilute vitriolic acid before mentioned in treating of vitriolated tartarin.

Application.

Since 514 grains of mere cauftic foda require 88180 of the dilute acid, 100 grains of foda would require 17155, and fince 1000 grains of this acid contains 7,425 of real acid, 17155 contains 127,37 grains. A refult which differs from mine by lefs than $\frac{1}{3}$ of a grain.

2d Experiment. 1 *Klapr.* 333.

100 grains of the thoroughly deficcated foda above mentioned require for their faturation 382 of a dilute vitriolic acid, formed of a mixture of 1 part vitriolic acid, whofe fp. grav. was 1,850 and 3 parts water, and the refulting neutral falt weighed 132,5 grains.

He alfo found that 1000 parts newly cryftallized Glauber, dried betwixt filtering paper, afforded by thorough deficcation in a fand-heat only 420 grains, and therefore loft 580.

Application.

THE ſp. grav. 1,850 is extratabular, lying between the tabular ſp. gravities 1,8542 and 1,8424, but nearer to the former; its acid contents are 79,14 per cent. then if 200 grains of this acid be diluted with 3 times that weight of water, we ſhall have 800 grains of a dilute acid, which will contain 79,14 x 2 = 158,28 grains of real acid; then 382 grains (the quantity employed by Klaproth) contain 75,57 of real acid, now 100 grains of deſiccated ſoda contain, as we have ſeen, 60 of mere cauſtic ſoda, and ſince 100 grains of mere ſoda require 127,68 for their ſaturation, 60 grains of ſuch ſoda ſhould require 76,60; the difference then between Klaproth's reſult and my determination is only 1,03 grains.

LASTLY, it may naturally be expected, that the reſulting neutral ſalt ſhould amount to the joint weight of the real acid and mere alkali, and conſequently ſhould in this caſe weigh 75,57 + 60 = 135,57 grains, which differs from Klaproth's reſult only by 3,07 grains, a loſs which may well be imputed to that which the ſalt ſuffers by evaporation.

THESE concordant experiments fully prove the accuracy of the table of vitriolic acid to a large extent, and of the proportion of ingredients I have aſſigned to ſoda, vitriolate tartarin and Glauber; for as Klaproth's experiments were made with an acid whoſe ſp. grav.

grav. was 1,850, Dr. Black's with an acid whofe fp. grav. was 1,798, and mine with an acid whofe fp. grav. was 1,565, we may be affured that to that extent (which includes 25 determinations) no material error exifts.

We muft not however imagine, that all mineral alkali contains the fame proportion of ingredients as foda; for the natural mineral alkali found in Africa, and called *trona*, contains a fomewhat larger proportion of fixed air and a much fmaller of water. 195,6 grains of trona, which Dr. Black had the goodnefs to fend me, were faturated by 260,5 of vitriolic acid 1,383, and gave out 66,5 grains of fixed air, therefore 100 grains of trona would require 133,18 of this acid for their faturation, and would lofe 34 grains of fixed air.

Now this acid differs infenfibly from the tabular, whofe fp. grav. is 1,387, which contains 40,18 grains per cent. real acid, and therefore 133,18 grains of it contains 53,5 of real acid. But we have fhewn that 100 parts real vitriolic acid faturate 78,32 of mere mineral alkali, therefore 53,5 grains of this acid faturate 41,9; this therefore is the quantity contained in 100 grains of trona, then 41,9 + 34 of fixed air = 75,9 and 1,8 grains of reddifh earth, confequently the remainder, that is 22,3 grains, were water.

Here we fee the alkali takes up more fixed air than ufual, for fince ufually 60 of the alkali take up 40 of fixed air, 41,9 of the

 pure

purc trona ſhould take up but 27,91, or nearly 28, whereas here it takes up 34, which is owing to its retaining but a ſmall portion of water during its cryſtallization.

Hence alſo we find the proportions in Mr. Keir's effloreſced but dry ſoda, for he tells us, that 100 grains of ſuch ſoda were ſaturated by 90 grains of vitriolic acid, whoſe ſp. grav. was 1,800; now this acid differs inſenſibly from the tabular, whoſe ſp. grav. is 1,807, which contains 75,89 real acid, conſequently 90 grains of this acid contains 71,9 real acid; and ſince 127,68 real vitriolic acid take up 100 of merc ſoda, 71,9 ſhould take up 56,31; and as 60 of mere ſoda take up 40 of fixed air, 56,31 ſhould take up 37,53, the ſum of both is 93,84, then the remainder of the 100, that is 6,16 parts, are water, which remained as it was not dried by ignition.

Mr. Keir alſo found that 100 parts of an impure Indian foſſil alkali contained as much rcal alkali as 58,8 grains of the above effloreſced and dry ſoda, and were ſaturated by 53 grains of the vitriolic acid 1,800. Now, from the proportions above ſtated, it will be ſeen that 58,8 of his ſoda contain 33,11 of mere alkali, and that 53 grains of the acid contained 40,22 of real acid, and that theſe ſhould ſaturate, and thereby indicate 31,5 of mere alkali, which differs from his reſult by 1,61 grains*.

Lastly, the proportions aſſigned to cryſtallized tartarin and to cryſtallized ſoda, and alſo the proportions of mere tartarin and mere

* Tranſ. of the Society of Arts and Manufactures. Vol. 6, p. 130, &c.

mere ſoda taken up by a given weight of real vitriolic acid, are confirmed by an experiment of Mr. Fourcroy's, 2 Ann. Chy. 289. for he found that the *ſame quantity* of vitriolic acid which ſaturated 193 grains of the cryſtallized ſoda alſo ſaturated 188 of cryſtallized tartarin. Now I have aſſigned 21,58 per cent. of mere alkali to cryſtallized ſoda, therefore 193 grains of it contain 41,6, and as the cryſtallized tartarin contains 41 per cent. of alkali, 188 grains of it contain 77. I have alſo ſhewn that 100 grains real vitriolic acid take up 78,32 of mere ſoda, and 121,48 of mere tartarin, then the harmony of theſe proportions with Fourcroy's experiments will thus appear: as 78,32. 121,48 :: 41.76,36; the difference between us is only 0,64 of a grain.

Section 3d.

Barolite and Baroselenite.

100 parts barytic earth precipitated from its ſolution in acids by a mild alkali, whether fixed or volatile, and heated to gentle ignition, contains 78 or 79 parts of earth, 21 or 22 of fixed air, about 1,5 are ſtronthian earth, a quantity which in this caſe deſerves little attention. See 1 Klapr 271. 2 Klapr. 82 and 86. 2 Chy. Ann. 1793, 196. 1 Chy. Ann. 1795, 111. Hence 100 grains barytic lime take up 28,2 of fixed air, and 100 grains of fixed air would precipitate 354,5 of barytic earth, and probably more, as the earth may not be ſaturated.

Baroselenite or Vitriolated Barytes.

Barytic Solutions being the moft delicate teft of vitriolic acid as yet known, the determination of the proportion of real vitriolic acid taken up in the artificial compound of both is of the greateft importance, and its agreement with the foregoing determinations will tend to their mutual eftablifhment.

I have already mentioned that by real vitriolic acid I mean acid of fuch ftrength or concentration as exifts in well-dried and neutralized vitriolated tartarin. If therefore I can fhew in what proportion the acid contained in a given weight of this falt enters into the compofition of a given weight of thoroughly dried barofelenite, the proportion of real acid in this laft will of courfe be demonftrated. Now this may very nearly be afcertained by the experiment of Dr. Withering, Phil. Tranf. 1784, p. 304. But firft I muft premife that by the experiments of the moft accurate analyfts, 100 parts barofelenite when fufficiently dried contain very nearly 33 of vitriolic acid.

The refults obtained by Dr. Withering were as follow:

1ft. 480 grains of barofelenite being fufed with 960 of falt of tartar, 428 grains of the barofelenite were decompofed, and 52 remained undecompofed.

2dly.

2dly. THE decompofed part neverthelefs weighed after decompofition only 360 grains.

3dly. 300 grains of vitriolated tartarin were alfo obtained.

IN this experiment we are only to attend to the 428 grs. which were decompofed, as the 52 that efcaped decompofition were no way altered.

IN the firft place it is plain that the 428 grains that were decompofed contained at leaft as much vitriolic acid as they imparted to the alkali in forming 300 grains of vitriolated tartarin: Now 300 grains of vitriolated tartarin contain $45 \times 3 = 135$ of real vitriolic acid, therefore 428 grains of barofelenite contain at leaft 135 of real vitriolic acid, that is, 31,5 per cent a quantity that already approaches pretty nearly to the direct refults of moft analyfts. But in the next place it is equally evident that the quantity of acid was greater than here ftated, and the quantity of mere barytic earth much below 360 grains, the quantity expreffed in the 2d refult; for if this quantity were juft, the fum of its weight and of that of the acid would furpafs the weight of the decompofed part. As inftead of 428 the fum would amount to $360 + 135 = 495$, which is impoffible. The truth then is, that thofe 360 grains of refiduary earth comprehend the weight not only of the mere earth, but alfo of the fixed air, which it had taken from the alkali in exchange for the acid it had imparted

imparted to it; consequently to find the true quantity of acid we must find out how much of the residuary 360 grains were mere earth, for by deducting this quantity from 428, the remainder will express the quantity of acid in the 428 grains.

THEN let the quantity of earth in the 360 grains $= x$, and the quantity of fixed air $= y$, then $x + y = 360$. and $x : y :: 78 : 21$ * nearly; and therefore $21\ x = 78\,y$, and $x = \frac{78\,y}{21}$, then $y + \frac{78\,y}{21} = \overline{360 \times 21} = 7560$, and $21\,y + 78\,y = 7560$ or $99\,y = 7560$, and $y = \frac{7560}{99} = 76{,}36$ grains of fixed air; and deducting this from 360, we have the quantity of mere earth $= 360 - 76{,}36 = 283{,}64$; and deducting this quantity from 428, we have the quantity of vitriolic acid $= 144{,}36$ grains; and lastly, if 428 baroselenite contain 144,36 of vitriolic acid, 100 grains baroselenite should contain 33,64.

THIS last quantity of acid somewhat exceeds the usual centenary proportion obtained by chymists, yet I believe the saturating proportion of acid to be still higher, for the following reasons:—— There are three ways of adding to each other an acid and earth or metal, the one by dropping the acid to be combined into the solution of the earth in an acid to which the earth hath a weaker affinity, and the other by inserting the earth immediately into the

* I say 21 rather than 22, as Dr. Withering himself states it at 20,8.

the acid with which it is to be combined, or by dropping its ſolution in a weaker acid into the acid with which it is intended to be combined. In the 1ſt mode of combination the ſaturation is ſcarce ever complete, becauſe the new compound in many caſes precipitates before it is fully ſaturated, and even though there ſhould be an exceſs of the acid to be combined in the liquor, yet the inferior part of the precipitate ſeldom receives it, being ſheltered by the ſuperior, and becauſe its affinity to its laſt complement of acid is much weaker than that to its *mean* proportion of acid.

But in the 2d or 3d mode of addition, the earth being ſurrounded by the acid with which it is to be combined, and thus expoſing a greater ſurface, takes up more of it and even frequently an exceſs, as I have often experienced.

This explains the difference which may be obſerved in the experiments I ſhall now ſtate:

1ſt. Dr. Withering having made a ſolution of 100 parts native aerated barytes in muriatic acid, dropped vitriolic acid into it until a precipitation ceaſed to appear; this artificial baroſelenite weighed 117 grs. Phil. Tranſ. ibid. 405. Now this native barytes contained but 78, 6 of pure barytic earth, as he had proved in a former experiment; therefore 78,6 of barytic earth took up as much real vitriolic acid as raiſed its weight to 117 grs. namely 38,4 grs.; and if 117 grs. baroſelenite contain 38,4 grs. of vitriolic acid, 100 parts baroſelenite muſt contain 32,8.

So alſo Klaproth tells us, that a baroſelenite which he had formed by dropping vitriolic acid into a muriated ſolution of aerated barytes contained barytic earth and acid nearly in the proportion of 2 to 1, conſequently 100 parts of it contained 66,66 of earth and 33,33 of real vitriolic acid. 2 Klapr. 72.* And p. 97 he tells us, he found the ſame proportion in another experiment, as 126 baroſelenite contained 42 of real acid.

On the other hand, Fourcroy having diſſolved 100 grs. native aerated barytes with the aſſiſtance of heat in very dilute vitriolic acid, found it to afford 138 grs. of baroſelenite, (inſtead of 117 which Dr. Withering had found by the 1ſt method) and that the barytic earth had taken up 48 parts vitriolic acid. Now if 138 parts broſelenite contain 48 of acid, 100 muſt contain 34,78. 4 Ann. Chym. 65.

Klaproth found that 85,5 grs. vitriolic acid whoſe ſp. grav. was 1,850, entered into the compoſition of 194 grs. baroſelenite, and by his own rule $\frac{1}{3}$ of theſe 194 grs. were real acid = 64,66; therefore 100 grs. of baroſelenite ſhould contain 33,33 grs. real acid. 1 Klapr. 153. By my table, as already ſaid, 100 grs. vitriolic acid, whoſe ſp. grav. is 1,850, contains 79,14 grs. real acid, therefore 85,5 grs. of this acid ſhould contain 67,7 real acid, and if

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* The baroſelènite in all theſe caſes was ignited, and he found that 185 grs. merely dried weighed after ignition 180, conſequently 100 parts of the merely dry loſe about 2,7 or 2,8 by ignition.

194 grs. barofelenite contain 67,7, 100 grs. of the barofelenite fhould contain 34,92, which differs from Klaproth's refults by 1,59 grs.

Again, Dr. Black, in the analyfis of Geyfer Waters, p. 117, tells us that 170 grs. barofelenite contain as much acid as 100 of fully deficcated Glauber. Now I have already fhewn by my own experiments that 100 grs. of deficcated Glauber contain 56,08 of real vitriolic acid, therefore 170 of barofelenite contain the fame quantity, and if fo, 100 grs. barofelenite muft contain 32,98, very nearly 33, which we fee fcarcely differs from Klaproth's proportion, the quantity of real acid being computed from my table.

Lastly, Klaproth found that 100 grs. of deficcated Glauber decompofed by acetited barytes gave 168 grs. of barofelenite. 1 Klapr. 333. Then 168 grs. barofelenite contain 56,08 of real vitriolic acid, and 100 fhould contain 33,38 of this acid. The confonance of thefe refults with my table may hereby be eafily difcerned. In general then the quantity of real acid in any quantity of ignited barofelenite may be difcovered by dividing it by 3, it being $\frac{1}{3}$ of the whole weight.

Hence 100 parts barytic earth take up 50 of real vitriolic acid, and would give 150 of barofelenite. And 100 grs. real vitriolic acid take up 200 of barytic earth, and afford 300 of barofelenite.

Section 4th.

Aerated Stronthian.

100 parts native aerated ſtronthian, or of the artificial ſufficiently dried, contain 31 of fixed air and 69 of earth.

Hence the quantity of air in any given quantity is found by multiplying this quantity into 0,31, and the quantity of earth by multiplying it into 0,69; then 100 parts of this earth are ſaturated by 45 of fixed air, and 100 parts of fixed air by 222,5 of this earth.

According to Dr. Hope, 100 grs. of cryſtallized ſtronthian lime contain 32 of earth and 68 of water.

Lowitz found 100 grs. of the artificially aerated ſtronthian to contain, when dried in heat, 32,5 per cent. of fixed air. 1 Chy. Ann. 1796. 128.

Per Pellitier, 100 grs. native aerated ſtronthian calcined with 10 grs. charcoal loſt only 28 grs. 21 Ann. Chy. 124.

Vitriolated Stronthian.

100 Parts vitriolated ſtronthian contain 42 of real vitriolic acid, for this is the quantity which muriated barytes ſeparated from the

tartarin

tartarin which decompofed 100 parts of vitriolated ftronthian, confequently the earthy part amounts to 58 grs. 2 Klap. 96, 97. Then 100 of this earth take up 72,41 of real vitriolic acid; and 100 grs. real vitriolic acid would take up 138 of ftronthian earth.

Section 5th.

Aerated Lime and Selenite.

In artificial aerated lime formed by precipitation, by foda or even by common tartarin, if added to excefs, the proportion of lime to fixed air is conftant, being as 55 of the lime to 45 of the air, that is, as 11 to 9, fo that the quantity of air being given that of the lime in the compound may be known; and if the compound be free from any other ingredient, and heated to rednefs to free it from water, then its weight being given the quantity of lime it contains is found by multiplying it into 0,55, and the quantity of air by multiplying it into 0,45; but whether dry or not, the weight of the air being found, the weight of lime is found by the 1ft analogy.

Mr. Bergman repeatedly afferts, that 100 grs. of calcareous fpar contain 55 of mere lime, 11 of water, and only 34 of fixed air. It always gives me concern to find my refults different from thofe of this great man, but on this occafion I am happily able to detect the caufes of this difference.

1ft.

1ſt. He tells us that by ſlow ſolution of 100 grs. of the ſpar in acids he found the loſs of weight to amount to 34 grs. only, though by applying a ſtrong heat he found it to amount to 45. Hence he concludes that in ſolution the fixed air ſingly was expelled, but that both fixed air and water were expelled by heat. Now to obtain a ſlow ſolution in acid he muſt have uſed a very dilute acid, and have employed a very narrow mouthed veſſel. In this caſe much of the fixed air is reabſorbed by the ſolution, as daily experience ſhews, and thus muſt have prevented his perceiving the real quantity of the air expelled from its combination with the earth.

Again Lavoiſier computes 100 grs. of chalk to have loſt about 34 grs. of air by ſolution in nitrous acid; but this loſs he inferred not from a direct trial, but from the weight of the volume of air found by compariſon with that of common air, calculated according to Mr. De Luc's rules. This concurrence muſt undoubtedly have confirmed Mr. Bergman in this erroneous eſtimation.

So alſo in natural lime-ſtones, the quantity of fixed air being found that of the lime is in the above proportion, except in a few caſes where magneſia exiſts in them or the lime not ſaturated. Hence 100 grains lime take up 81,81 of fixed air, but 100 grains of it are precipitated by ſomewhat leſs. Klaproth eſtimates the proportion in this at 4 of fixed air to 5 of lime. And 100 grains fixed air ſaturate 122,24 of lime, but would precipitate 125.

Section

Section 6th.

SELENITE.

THERE are two ways of combining vitriolic acid with lime and and ſome other ſubſtances; one by *direct ſolution* or addition of the baſis unto perfect ſaturation, ſo as no longer to diſcolour the uſual teſts, the other by precipitation from another menſtruum; in this laſt method the baſis takes up an exceſs of acid, which as it is waſhed off in other purſuits occaſions no miſtake, though it does in this.——The 1ſt experiment in my laſt paper I followed the 1ſt method, in it I found that 439 grains of a mixture of 225 grains of vitriolic acid whoſe ſp. grav. at 60° was 1,5654, with 225 of water, ſaturated 152 grains of marble which contained (at the rate of 55 per cent.) 83,6 of lime By the table it appears, that the vitriolic acid before dilution contained 54,46 real acid, then 439 of the dilute acid contained 119,5 of real acid, conſequently 83,6 of lime took up 119,5 of real vitriolic acid, therefore if the compound of both were free from water, we ſhould have its weight equal 83,6 + 119,54 = 203,14 nearly, and 100 parts of it would contain 41,15 lime and 58,84 of real acid.——But unleſs the compound be expoſed to a high heat this weight cannot be expected; the reſulting ſelenite will always retain a proportion of water, varying with the degree of heat to which it was expoſed, and it is this that occaſions the variety of determinations of the proportion

portion of ingredients in ſelenite, when, as in this experiment, its ingredients are directly combined; yet the proportion taken from the quantity of precipitate is more fallacious, as will preſently be ſhewn.

In this direct experiment the quantity of ſelenite obtained after deſiccation in a heat not exceeding 170°, amounted to 237.25 grains, of theſe 203,14 were lime and real acid; the remainder then *v: z* 34,11 were water; then by the rule of proportion 100 grains of this ſelenite ſhould contain 14,38 of water, conſequently 85,62 were lime and acid. And if 100 parts of ſuch compound contain 41,15 of lime, as already ſeen, 85,62 ſhould contain 35,23, and deducting this from 85,62, we have 50,39 for the acid part, conſequently the centenary proportion of ingredients in ſelenite dried at about 165° is as follows:

Real vitriolic acid -	50,39
Lime - - -	55,23
Water - -	14,38
	100,00

If the ſelenite were dried by mere expoſure to the air, the quantity of water in 100 parts of the ſelenite would be greater, and that of the lime and acid ſmaller, and if it were ignited the proportion of theſe laſt would be greater, and that of the water ſmaller,

ſmaller, as is evident; but by expoſing any quantity of it to a ſtrong red heat the water will, for the moſt part at leaſt, be expelled, and the proportion of the other ingredients may be determined very nearly by the above analogy, if the ſelenite be ſaturate and free from foreign ingredients.

THE experiments I made in precipitating lime from the nitrous and marine acids by the vitriolic, and alſo by vitriolated tartarin, I found to be fallacious, as much of the ſelenite remains in ſolution in theſe acids, and conſequently it is not poſſible to limit or diſcover the proper addition of the precipitant. Hence 100 *grains lime* take up 143 nearly of real vitriolic acid, and afford about 284 of ſelenite thus dried and formed. And 100 grains real vitriolic acid take up nearly 70 of lime, and afford 198 of ſelenite thus dried and formed.

100 grains lime precipitated by vitriolic acid take about 15,8 per cent. exceſs of real acid, and vitriolated tartarin does not precipitate the whole of it without repeated evaporations and additions.

Experiment 1ſt. 1 *Klaproth*, 195.

ACCORDING to Klaproth 100 grs. of vitriolic acid, whoſe ſp. grav. was 1,850 (neglecting he ſays inſignificant fractions) were ſaturated by 55 of lime or 100 of aerated lime, and afforded 160 grs. ſelenite.

Application.

100 grs. of the vitriolic acid 1,850 contain 79,14 grs. per cent. of real acid as already feen; then if there were no water in the compound its weight would be 79,14+55=134,14 grs. but he found the weight to be 160, then the difference or 160—134 muft be water=26 grs.

Then the centenary proportion was { 49,47 real vitriolic acid
34,37 lime
16,25 water
———
100,00

This proportion we fee fcarcely differs from mine and therefore his felenite was probably expofed to nearly the fame heat.

Experiment 2d. 2 Klaproth, 124.

IN this experiment he tells us the felenite was heated to *ignition*, and confequently we may fee the difference of proportion produced by that heat. 38 grs. of it contained 14,75 of lime; the quantity of acid is not mentioned.

Application.

Application.

By his own proportion 14,75 lime ſhould take up 21,22 of real acid, for as 55 : 79,14 :: 14,75 : 21,22 nearly, then 1745. + 21,22 = 35 97, conſequently the remainder *v. z.* 2 grs. were water, then the centenary proportion ſhould be

as 38 : 14.75 :: 100 to	38,81 lime
38 : 21,22 :: 100 to	55,84 real acid
then the remainder is	5,35 water
	100,00

Experiment 3d. 1 *Bergm.* 135.

Bergman's ſelenite is cryſtallized and contains ſo much water that it is plain he ſuppoſes it dried by mere expoſure to the heat of the atmoſphere.

according to him 100 grs. contain	46 vitriolic acid
	32 lime
	22 water
	100

Hence 1ſt, we have the proportion of ſelenite dried in 3 different degrees of heat, that of ignition, that of the atmoſphere, and that between 130° and 170°.

2dly. We may now explain and do juftice to the *firft* experiment of Mr. Wenzel on this fubject. He diffolved 240 grs. of clean oyfter fhells in his fpirit of nitre, and precipitated the lime contained in them by dilute vitriolic acid, he then evaporated the whole, firft to drynefs and afterwards by gentle ignition to expel the excefs of acid, and laftly expofed the felenitic mafs to a more intenfe heat for one hour, then weighing it in the fame veffel found the felenite to weigh 309,75 grs.

Application.

The 240 grs. of purified oyfter fhells contained 126,72 grs. of lime, which I prove thus, he tells us p. 101, that 81 grs. of the fame oyfter fhells gave out during folution 35 grs. of fixed air, confequently 100 grs. would give out 43,2 ; now we have already feen that 45 grains of fixed air denote the prefence of 55 of real calcareous earth in 100 parts aerated lime, therefore 43,2 denote 52,8 of lime and therefore 240 parts of thefe fhells contained 126,72.

Now as to the acid, fince 100 parts lime take up 143 126,72 fhould take up 181,20 and the felenite being fo ftrongly heated fhould weigh only the fum of both *v. z*: 181,20 + 126,72 = 307 92 or 308, grains which wants only 1,75 of the weight found by Wenzel, this increafe found by him I impute to fome phofporated lime originally in the fhells, the acid of which was not expelled in the above experiment.

Wenzel

Wenzel was ſet aſtray by his 2d experiment; for having calcined 240 grains of his ſhells for 4 hours he concluded they were wholly converted into lime and he found their weight 133,5, but here lay the miſtake, he had no proof that 3 or 4 grains did not remain uncalcined, and the preſence of phoſphorated lime he did not ſuſpect. In a third experiment he came very near the truth for he concluded the quantity of lime to be 125 grains, but the difference between this and 133,5 he attributed to the *cauſticum*.

Section 7.

Of Magnesia and Epsom.

This earth may be obtained in three ſtates, either *fully aerated and cryſtallized*, and then from its great ſolubility in water it may be called a ſalt; or *imperfectly aerated*, ſuch as *common magneſia*; or *perfectly deaerated* and freed from water by a white heat.

The proportion of ingredients even in cryſtallized magneſia are differently ſtated, probably from having undergone ſome unperceived effloreſence; according to Fourcroy who ſeems to have beſtowed moſt attention to this object, 100 parts cryſtallized magneſia contain

	50	fixed air
	25	magneſia
	25	water
	100	

hence

hence they lofe 75 per cent. of their weight when ftrongly heated 2 An. Chy. 297, 298.

But according to 1 Bergm. 29 and 373, the chryftallized contains but 30 per cent. of fixed air, with whom Butini agrees, but he afterwards found even common magnefia to contain a larger proportion, fee p. 23 and 146 of his treatife; of the other ingredients neither mentions the proportion.

In *common* magnefia the proportions are, according to Bergman

45	of earth
25	fixed air
30	of water
100	

And according to Butini p. 146,

40,62	earth
37,5	fixed air
21,88	water
100,00	

According to Fourcroy 100 parts of common magnefia contain

40	earth
48	fixed air
12	water
100	

confequently they fhould lofe 60 per cent. in a white heat.

Consequently

Consequently per Bergman 100 grs. common magnefia fhould lofe 55 per cent. in a ftrong heat, and per Butini it fhould lofe nearly 60, and with this determination two experiments of Klaproth's agree. See 2 Klapr. 9 and 20; yet in another experiment the lofs was but $\frac{46}{100}$, 2 Klap. 174.

Hence we fee the proportions of air and water are variable, but the fum of both generally amounts to 55 per cent. at the leaft, and and hence I rate the mere earthy part in common magnefia at 45 per cent. when by a ftrong heat lefs is found I believe the difference to have been volatilized. The various proportions of fixed air arife from the various proportions of it contained in the different precipitants ufed in obtaining magnefia.

Note however, the water may gradually be expelled from common magnefia in a heat much below ignition.

Epsom.

In my former paper I have ftated that 35 grains of common magnefia, containing 15,75 of mere earth, were faturated by 50 grains of vitriolic acid, whofe fp. grav. was 1,5654, diluted with a large proportion of water, but containing, as appears by the table, 27,23 real acid, and from this and a comparative experiment, I deduced that 100 parts of cryftallized Epfom contained 17 of mere earth,

earth, 29,35 of real vitriolic acid, and 53,65 of water, it was ſtandard acid that I had before mentioned, but its quantity of real acid is as I now ſtate it, as may be ſeen by calculation.

HENCE 100 parts perfectly deſiccated Epſom ſhould contain 36,68 nearly of earth, and 63,32 nearly of real acid.

AND 100 grains mere magneſia take 172,64 real vitriolic acid, and ſhould afford 590 nearly of cryſtallized Epſom.

AND 100 parts real vitriolic acid ſhould take up 57,92 of magneſia, and afford 340 nearly of cryſtallized Epſom.

ACCORDING to Bergman 100 grains of magneſia take up 173 of real vitriolic acid.

ACCORDING to Wenzel 100 grains magneſia take up 181,8 real acid, this ariſes from his rating the mere earthy part of common magneſia at 41,2 per cent. which, as I think, ariſes from volatilization of part of the magneſia.

Experiment 1ſt. Fourcroy, 2 *An. Chy.* 285,282.

HE found that cryſtallized tartarin taken in the proportion of 80 parts to 100 of cryſtallized Epſom operate an *almoſt total* decompoſition of the Epſom.

Application.

Application.

As 100 parts cryſtallized tartarin contain, as already ſaid, 41 of vegetable alkali, 80 parts of it muſt contain 32,8, but as 100 parts of this alkali take 82,48 of real vitriolic acid, 32,8 ſhould take 27,05, which is nearly the whole of what 100 parts of Epſom contain.

Experiment 2d. Fourcroy, 2 *An. Chy.* 288.

CRYSTALLIZED ſoda, applied in the proportion of 108,8 to 100 of cryſtallized Epſom, perfectly decompoſed the Epſom.

Application.

100 parts cryſtallized ſoda contain, as already ſhewn, 21,58 of mere alkali, conſequently 108,8 parts contain 23,479. Now 100 parts of this alkali take up 127,68 of real vitriolic acid; therefore 23,479 ſhould take 29,97, which differs from the quantity of acid I have aſſigned to 100 parts cryſtallized Epſom only by 0,62 of a grain.

Section 8th.

ALUM.

THE combinations of argill with vitriolic acid are ſo diverſified, as Mr. Vauquelin has lately ſhewn in a ſeries of curious and intereſting experiments, that to aſcertain the limits of each would require a particular examination which the generality of the preſent inquiry does not at preſent permit to enter into.

THE reſult of my former eſſay was, that 100 parts alum contain 31,34 of earth dried at 465°; 17,66 of real vitriolic acid, and 51 of water; but the acid contained in vitriolated tartarin, of which alum may contain 6 or 7 per cent. is not noticed; but being counted the whole amounts to 20 per cent.

THE earth heated to *whiteneſs* may be reduced to 18, or ſtill fewer parts. Wenzel and others ſay 11,7, and I believe this to be moſt exact.

HENCE 100 grains burnt alum, that is alum from which its water was expelled, ſhould contain 35,4 of real acid. But the alums of different countries differ much. See Vauquelin in An. Chy. & Pref. to 1 Laborant. VII.

Section 9th.

VITRIOL OF IRON.

100 parts of this vitriol newly cryſtallized contain by my determination 28 calx of iron in the ſtate of œthiops, equal nearly 22 of metallic iron, 26 real vitriolic acid, 38 water of cryſtallization, and 8 water of compoſition, that is which adheres to the acid. This determination I lately confirmed; for from a ſolution of 100 grains of this vitriol decompoſed by muriated barytes I obtained 77,25 of ignited baroſelenite, which at the rate of 33,3 per cent. contained 25,747 of real vitriolic acid.

HENCE 100 parts vitriol of iron calcined to redneſs contain 41,93 of real acid, and 12,9 of water; but the calx of iron will weigh more than 45, as it attracts oxygen during the calcination.

THE water of compoſition is for the moſt part expelled with the acid during diſtillation. Then 22 grains metallic iron ſhould afford 100 grains of cryſtallized vitriol; and 100 grains of the beſt iron would give 454,54 of vitriol.

THE vitriol above examined was of a full *graſs green colour*. I have met with another which is of a pale ſea green colour, and contains much leſs acid, for 100 grains of it treated as above afforded only 56,7 of baroſelenite, and conſequently contained but 18,99 of real acid.

Section 10th.

Vitriol of Lead.

By the experiments of Klaproth, 100 grains vitriol of lead ſhould contain about 71 of metallic lead ;* by thoſe of Bergman and Wenzel nearly 70; but as the lead, being precipitated from the nitrous acid, is in a calcined ſtate, we may add 4 of oxygen.

Again, Wolfe found 120 grains vitriol of lead decompoſed by tartarin to afford 65 of vitriolated tartarin; therefore 100 grains of this vitriol would afford 54,16 of vitriolated tartarin. Now this quantity of vitriolated tartarin contains 23,37 of real vitriolic acid; therefore juſt ſo much is contained in 100 grains of vitriol of lead. Phil. Tranſ. 1779. and 10 Roz. 368.

Hence the quantity of ingredients *in* 100 *parts of this ſalt* are 75 calx of lead, (= 71 of metallic lead) 23,37 real vitriolic acid, and 1,63 water.

Hence 100 *grains metallic lead* (with the addition of oxygen) take up 32,91 of real vitriolic acid, and afford 140 of vitriolated lead.

And 100 *parts real vitriolic acid*, unite to 303,8 of metallic lead, (when calcined) and afford 425,49 of vitriol of lead.

According

* See 1 Klapr. p. 169, and 173; and 2 Klapr. p. 219.

According to Bergman, 100 grains metallic lead would afford 143 of vitriol of lead.

According to Wenzel 143,33.

According to Wolfe 137,5. He precipitated the nitrous ſolution of lead by vitriolated tartarin, and probably did not apply enough, or this ſalt did not diſengage the laſt portions of the nitrated lead, or ſome part of the vitriol of lead remained in the nitrous acid. This laſt ſuppoſition is highly probable.

Vitriol of Copper.

100 grains of this ſalt, perfectly cryſtallized, loſt 28,5 by expoſure to a heat of 370°.

By precipitation with muriated barytes they afforded 91 of ignited baroſelenite, and hence contain 28,5 of water of cryſtallization and 30,33 of real vitriolic acid; and conſequently about 40 of calx of copper = 32 of metallic copper.

Vitriol of Zinc.

100 grains of vitriol of zinc, cryſtallized in needles, loſt in a heat of 375° 39 grains; and 100 grains of the ſame cryſtals, being diſſolved and treated with muriated barytes, afforded 61,24 of ignited baroſelenite, and hence contain 20,414 grains of real vitriolic acid.

CHAP.

CHAP. III.

OF NITRO NEUTRAL SALTS.

Section 1ſt.

Of Nitre.

From the different reſults of various experiments, I am led to think that 100 parts of cryſtallized, but dry nitre, contain 51,8 parts mere alkali, 44 of acid and 4 of water of compoſition.

Hence 100 parts tartarin take up 84,96 of real acid with 8,1 of water, and would afford 193 + of dry nitre.

And 100 grains real nitrous acid take up 117,7 of tartarin, and would afford 227,24 of nitre, by reaſon of 9,54 of water of compoſition, which in this caſe accompanies the acid.

This is the beſt account I am at preſent enabled to give of nitre, the inveſtigation of the proportion of the acid contained in ſp. of nitre, being attended with peculiar difficulties, as much as the acid eſcapes, when, in its concentrated ſtate, water is added to it, and ſo much the more as it is more highly mephitized and the temperature

temperature higher. The more it is mephitized the more alkali it appears to ſaturate, but afterwards the ſalt extracts oxygen from the air; when melted it alſo loſes part of its oxygen and of its water of compoſition, but in time ſeems to regain them.

According to Wenzel, 83,5 parts tartarin were ſaturated by 90 of his ſtrongeſt acid, and the compound heated to redneſs weighed 173,5.

Then 100 grains tartarin ſhould take up 107,78 of his ſtrongeſt acid (= 87,51 of my real acid) and afford 207,78 of dry nitre.

And 100 parts nitre contain, by his account, 48,13 of alkali, and 51,87 of his ſtrongeſt acid, = 42,118 of my real acid.

According to Bergman, 49 parts tartarin afford, when ſaturated with nitrous acid, 100 parts nitre, conſequently 100 parts tartarin would afford 204.

Lavosier * allows nearly 49 per cent. of alkali and 51 of acid (including water) to 100 grains of nitre.

Berthollet, in the Memoirs of the Royal Academy for 1781, obſerves, that 480 parts of nitre afford, by diſtillation, 714 cubic inches of ſomewhat impure oxygen air, then 100 parts of nitre would

* P. 157 of the Engliſh Edition of his Elements of Chymiſtry.

would afford 148,7 (Engliſh meaſure), theſe at the rate of 33 per cent. would weigh 49,07 grains, including water loſt, which differs but little from my account.

KIER found 22,5 grains dry nitre were ſaturated by 12,54 grains vitriolic acid, 1,844. Phil. Tranſ. by my determination 22,5 grains nitre contain 11,655 grains tartarin (for if 100 grains nitre contain 51,8 : : 22,5, 11,655) and 11,655 grains tartarin require 9,61 of real vitriolic acid for their ſaturation.

Now the ſp. grav. 1,844 is intermediate between the tabular gravities 1,8542 and 1,8424, but nearer to the latter; then by the 1ſt problem its centenary acidity will be found to be 78,58, and if 100 grains of this acid contains 78,58 real acid, 12,54 ſhould contain 9,85, the difference is not quite $\frac{1}{4}$ of a grain. Mr. Kier required 12,54 of this acid, by my determination 12,23 are ſufficient, the difference is not $\frac{1}{3}$ of a grain. Phil. Tranſ.

KLAPROTH found 200 grains of Leucite, treated with marine acid, to afford 70 of muriated tartarin; and that 300 of that ſtone, treated with nitrous acid, afforded 123 of nitre. Now by Bergman's calculation 100 grains muriated tartarin contains 61 of alkali, therefore 70 grains ſhould contain 42,7.

BY my calculation 100 grains muriated tartarin contains 64 of alkali, therefore 70 ſhould contain 44,8 of alkali.

THEN

THEN 100 grains Leucite ſhould contain, per Bergman, 21,35, and by my calculation, 22,4.

BY Bergman's calculation there is a *deficit* of 0,27 of a grain, and by mine an exceſs of 0,77 of a grain. See 2 Klaproth, 50.

BUT with reſpect to nitre, my calculation has the advantage both over his and Wenzel's, for ſince 300 grains Leucite afford 123 of nitre, 100 grains of this ſtone ſhould afford 41. Then by Bergman's account, 41 grains ſhould contain 20,09 of alkali, which leaves a deficit of 2,16 grains; by my determination 41 grains of nitre contain 21,238, which leaves a deficit of only 1,012 grains:

For the calculation ſtands thus:	Silex	53,50	Silex	53,50
	Argil	24,25	Argill	24,25
	Tartarin	20,09	Tartarin	21,238
		97,84		98,988

Section 2d.

NITRATED SODA.

IN my former experiment 36,05 grains of mere ſoda were ſaturated by 145 of nitrous acid, whoſe ſp. grav. at 60° was 1,2574; this denſity is intermediate between the tabular ſp.

gravities 1,2779 and 1,2687, but nearer to the former, and by the ſolution of the 1ſt problem will be found to denote 33,8 grains real acid; conſequently 145 grains of this liquor contained 49 grains of real acid. The quantity of nitrated ſoda formed was found by a ſtandard experiment to be 85,142 grains, which is very nearly the ſum of the weights of the real acid and mere alkali, as 36,05 + 49 = 85,05; this trifling difference may be water.

HENCE 100 parts deſiccated nitrated ſoda ſhould contain 57,57 real acid and 42,34 ſoda.

THEN 100 parts ſoda ſhould take up 135,71 of real nitrous acid. And 100 parts nitrous acid ſhould take up 73,43 of ſoda.

SURPRISED at finding no water in this neutral ſalt, I lately examined its compoſition by my antient method. I diſſolved 200 grains of pure and well deſiccated ſoda, and ſaturated the ſolution with 1225 grains of dilute nitrous acid, of which $\frac{1}{4}$ conſiſted of the concentrated acid 1.416, of which conſequently 306,2 were employed; the loſs of fixed air was 75 grains, and conſequently the quantity of real alkali was 125 grains.

THE ſp. grav. 1,416 lies between the tabular gravities 1,417 and 1,412, and by the ſolution of the 1ſt problem its centenary quantity of acid will be found to be 53,53; and 100 grains of this

this acid liquor being diluted with 300 of water, then 400 grains of the dilute acid contain 53,53 real acid; and confequently 1225 grains of it contained 163,9 grains; this quantity therefore was taken up by 125 of foda; if therefore the falt thus formed contained no water the fum of both thefe quantities fhould exprefs its weight, namely, 163,9 + 125 = 288,9 grains; but having very gently evaporated the folution, namely, in a heat not exceeding 120°, and then drying the refiduum in a heat of 400° for fix hours, I found it to weigh in the evaporating difh (from which I could not feparate it without lofs) 308 grains, confequently thefe 308 grains contained 19,1 of water, however it is evident that in a greater heat even thefe would be evaporated.

And then very nearly the fame proportion of acid and alkali would be found as in the preceding experiment, for 308 — 19,1 = 288,9, and if 288,9 grains contain 125 of alkali, 100 grains of the nitrated foda fhould contain 43,27, and confequently 56,73 of acid; and allowing 19 grains of water in 308 of this falt dried at 400°, then 100 grains nitrated foda fhould contain 40,58 of foda, 53,21 of real nitrous acid, and 6,21 of water.

And 100 grains mere foda faturated with nitrous acid fhould afford 246,42 of nitrated foda dried at that heat. And 100 grains real nitrous acid faturated by foda fhould give 188 nearly of nitrated foda dried as above.

Bergman, Vol. I. p. 20, allows to 100 parts ſoda very nearly the ſame quantity of real nitrous acid as I do, namely, 135,5 parts.

Having re-diſſolved the above 308 grains and expoſed the ſolution to ſpontaneous evaporation, I found the cryſtals dried at 70° to weigh 317 grains; hence this ſalt contains 2,8 per cent. of water of cryſtallization, but in a ſtrong heat it would loſe much more.

Though Wenzel's determinations ſeemingly differ conſiderably from the foregoing, yet on a cloſer inſpection the difference will be found not greater than the uſual imperfection of weights and weighing, and the varying nature of the acid may admit.

He found 71,5 grains mere ſoda ſaturated with nitrous acid to afford 190,75 of thoroughly deſiccated nitrated ſoda, and hence concluded that it contained no water, and conſequently 190,75 grains of this ſalt to contain 71,75 of alkali and 119,25 of real acid.

Hence 100 *grains of this ſalt* ſhould contain 37,48 of alkali and 62,52 of acid; it is plain then that this acid contained the 6,21 grains of water which I found in 100 parts of this ſalt, for if we add 6,21 to the quantity of acid I aſcribe to 100 parts of this ſalt, we ſhall find very nearly Wenzel's weight of acid, for $53{,}21 + 6{,}21 = 59{,}42$.

According

According to Wenzel, then, 100 grains mere ſoda take up 166,7 of this aqueous acid, and ſhould afford 266 of nitrated ſoda thoroughly deſiccated; and 100 grains of the aqueous acid ſhould take up 59,9 of ſoda.

From the experiment on nitrated ſoda Wenzel deduces the ſtrength of his ſp. of nitre, which being the ſame as he employed in his ſubſequent numerous experiments it is important to diſcover.

As he ſaturated 71,5 grains ſoda with 347 grains of this ſp. of nitre and found the ſoda to take up 119,25 of what he thought the ſtrongeſt nitrous acid, he concluded that 240 grains of it contained 82,5 of the ſtrongeſt acid, and conſequently 100 grains of it ſhould contain 34,375 of his ſtrongeſt acid. Now to compare the quantity of his real acid in his ſp. of nitre with that which I judge his to poſſeſs, I muſt obſerve that to ſaturate 71,5 grains mere ſoda, 96,933 grains of my real acid would be requiſite, and conſequently that 347 grains of his ſpirit of nitre contained no more; therefore 240 grains of his ſpirit of nitre contained but 6- 04 of my real acid, and 100 grains of it contained 28 of my real acid; the difference is water contained in his ſtrongeſt acid. Then 1000 grains of his ſtrongeſt acid is only equal to 812,6 of my real acid; the remainder *v. z.* 187,4 being water contained in his ſtrongeſt acid.

Morveau

MORVEAU ſaturated 485 grains of cryſtallized ſoda (= 104,66 of mere ſoda) with 545 grains of ſpirit of nitre, whoſe ſp. grav. at 4° of Reaumur (= 41° of Fahrenheit) was 1,2247, which at 60° of Fahren. would be 1,219, and this by my calculation contains about 27,29 per cent. real acid; conſequently 545 grains contained 148,73; then 100 grains mere ſoda ſhould take up 142 of real nitrous acid. 2d Old Mem. Dijon 184.

LAVOSIER alſo ſaturated a given quantity of ſoda with nitrous acid, but as there was an exceſs of acid no ſtreſs can be laid on his experiment.

I found nitrated ſoda to attract moiſture in a moderate degree.

NITRATED BARYTES.

As barytic earth cannot well be diſſolved in nitrous acid without the aſſiſtance of heat, I was obliged to attempt the analyſis of this ſalt by indirect methods, namely, precipitation by cryſtallized ſoda and vitriolated tartarin.

THE ſoda I employed contained 15 per cent. of fixed air, and 21,5 of mere alkali; and 100 grains of aerated barytes ignited contains about 21,5 of fixed air.

NOW I found that 100 grains of cryſtallized nitrated barytes were precipitated by 105 nearly of this ſoda, and that the earth after

after edulcoration, deficcation and ignition, weighed 70,25 grains nearly; but at the rate above-mentioned thefe 70,25 grains are reducible, deducting the fixed air to 55,10 of pure barytic earth.

On the other hand 108 grains of cryftallized foda contain 23,22 grains of mere foda, and thefe we have already feen are capable of taking up 31,41 of real nitrous acid, therefore by this experiment 100 grains of cryftallized nitrated barytes contain 31,41 of acid and 55,10 of earth; the remainder then is water of cryftallization, = 13,49 grains.

Again, 100 grains of cryftallized nitrated barytes were diffolved in 2400 of water, and precipitated by the gradual addition of a folution of vitriolated tartarin; the precipitate which was flowly and difficultly formed and collected weighed after ignition about 88 grains; thefe (at the rate of 33,33 per cent.) contained 29,33 of real vitriolic acid, and confequently 58,67 of mere earth.

Taking a mean, then, of thefe two experiments, 100 grains of nitrated barytes contain 56,88 grains of mere earth.

Lastly, 308 grains of native aerated barytes diffolved in 240 of nitrous acid, whofe fp. grav. was 1,451, diluted with 5 times its weight of water in a gentle heat afforded 384 grains of cryftallized nitrated barytes, befides a fmall refiduum.

Now

Now this acid contains 58 per cent. real acid, and confequently 240 grains of it contained 139,2 of real acid; and if 384 grains of the cryftals contain 139,2, then 100 grains fhould contain 36,25. But it muft be confidered that fome was contained in the mother liquor, fome in the cryftals that were not wafhed, but dried on filtering paper, and fome was difperfed by the heat applied.

THIS experiment alfo gives fome, though not an accurate information of the proportion of earth in nitrated barytes, for 308 grains of aerated barytes (at the rate of 21,5 per cent.) contain 66,22 of fixed air, and confequently 241,78 of mere earth. Suppofing then 384 grains of nitrated barytes to contain this quantity of earth, 100 grains of this falt fhould contain 62. But this fuppofition is inadmiffible by reafon of the loffes juft mentioned.

UPON the whole we may ftate the centenary proportion of this falt at 57 of earth, 32 real acid, and 11 of water.

HENCE 100 grains barytic earth take up 56 of real nitrous acid, and fhould afford 175,43 of nitrated barytes. And 100 grains real nitrous acid fhould take up 178,12 grains of barytic earth, and fhould afford 312,5 of nitrated barytes.

100 grains of this falt loft only $\frac{1}{2}$ a grain of its weight by expofure to a heat of 300° for half an hour. It is alfo difficultly foluble. Its folution when faturated does not redden Litmus.

NITRATED

NITRATED STRONTHIAN.

100 grains of perfectly cryſtallized nitrated ſtronthian, diſſolved in 480 of water, were precipitated by about 107 of cryſtallized ſoda, containing 16 per cent. of fixed air and 21,5 of mere alkali, the precipitate, after ignition, weighed 53,25 grains, and contained 17,04 of fixed air, and conſequently 36,21 of mere earth.—Alſo the 107 grains of ſoda (at the rate of 21,5 per cent.) contained 22,9 of mere alkali, which (at the rate of 135,71 per cent.) took up 31,07 of real nitrous acid; then by this experiment 100 grains cryſtallized nitrated ſtronthian contain 36,21 of earth, 31,07 of acid, and 32,72 of water.

THEN 100 grains of pure ſtronthian earth take up 86 nearly of real nitrous acid, and ſhould afford 276 of cryſtallized, or about 92 of thoroughly deſiccated nitrated ſtronthian.

AND 100 grains real nitrous acid ſhould take up 116,5 of mere ſtronthian earth, and afford 321 of cryſtallized, or 107 of thoroughly deſiccated nitrated ſtronthian.

Section 3d.

NITRATED LIME.

IN my experiment 136 grains Carrara marble were ſaturated by 400 of nitrous acid, whoſe ſp grav. was 1,2754, and which conſe-

quently contained (at the rate of 33,59 per cent.) 134,36 real acid. The 136 grains Carrara marble contained (at the rate of 55 per cent.) 74,8 of lime.

CONSEQUENTLY 100 parts lime take up 179,5 of real nitrous acid, and 100 parts real nitrous acid take up 55,7 of lime.

LAVOSIER diſſolved 972 grains of ſlacked lime, dried in a heat of about 600°, in 3456 grains of nitrous acid, whoſe ſp. grav. was 1,2989, and conſequently contained (at the rate of 36,7 per cent.) 1268 grains real acid; from the 972 grains lime we muſt deduct (at the rate of 28,7 per cent. water abſorbed in the ſlacking) 268,9 of water, and alſo 35 grains of fixed air, abſorbed while ſlacking and drying, there remain then 668 of mere lime, and theſe took up 1268 of real acid, then 100 grains of lime would take up 190 of real acid. 1 Lavoſier, 198. Perhaps the difference ariſes from my computing the quantity of real acid from a ſpecific gravity taken at 60°, whereas his might have been taken at a higher degree.

BERGMAN found 100 grains of nitrated lime, *well dried* (that is dried in air) to contain 32 of lime; by the above analogy the proportion of the other two ingredients may be found, for ſince 100 parts lime take 179,5 of real acid, 32 ſhould take 57,44, conſequently the remainder, viz. 10,56 are water; if the nitrated lime could be perfectly dried, it would contain about 36 per cent. of lime and 64 of real acid.

ACCORDING

According to Wenzel 122,66 grains of lime take up 240 of his strongest acid, consequently 100 of lime would take up 195,64 of such acid, but this quantity is equivalent to only 159 of my real acid, this difference I cannot account for.

Section 4th.

NITRATED MAGNESIA.

By my experiment 100 parts mere magnesia require 210 of real nitrous acid for their saturation.

And 100 grains real nitrous acid take up 47,64 of mere magnesia. 100 grains crystallized nitrated magnesia contain 46 real acid, 22 magnesia, and 32 of water, as I found.

According to Wenzel 77 grains of the magnesia he employed contained but 32,13 mere earth, and yet required 240 of his sp. of nitre for their saturation, which sp. of nitre, by my calculation, contained but 67,2 real acid, and consequently 100 grains mere magnesia would require 209 real nitrous acid; by his own calculation 240 of his sp. of nitre contained 82,5 of his strongest nitrous acid, and consequently 100 grains mere magnesia should take up 256 of such acid, = 207,87 of my real acid.

According to Fourcroy, 4 An. Chy. 214, 150 grains aerated magnesia, containing 48,66 per cent. mere magnesia, and consequently in all 73 grains, were saturated by 222 grains of nitrous acid, whose sp. grav. appears to have been 1,5298, of which 100, by my table, contain 69,88 real acid, and consequently 222 contain 155; and if 73 grains mere magnesia take up 155 real acid, 100 grains mere magnesia should take up 212.

CHAP.

CHAP. IV.

OF MURIATIC NEUTRAL SALTS.

Section 1st.

OF MURIATED TARTARIN.

IN my laſt paper I have ſtated that 86 grains of mere tartarin were ſaturated by 254 grains of muriatic acid, whoſe ſp. grav. at 60° was 1,1466; this is extratabular, but intermediate between the tabulated ſpecific gravities 1,147 and 1,1414, but nearer to the higher, and its centenary acid contents will be found by the 1ſt problem to be 19,06; conſequently 254 grains of this acid liquor contained 48,412 real acid; the ſum of the acid and alkaline parts then amounts to 48,412 + 86, = 134,412 of muriated tartarin; and ſince 134,412 of this ſalt contained 86 of alkali, 100 parts of the dry ſalt ſhould contain 64 nearly of tartarin, and the remainder or 36 parts are real marine acid.

HENCE 100 grains tartarin take up 56,3 of real marine acid, and ſhould afford 156,3 of well dried muriated tartarin. And 100 grains real marine acid ſhould take up 177,6 of mere tartarin, and afford 277,6 of deſiccated muriated tartarin.

WENZEL

Wenzel found 83,5 grains of tartarin to afford him 129 of muriated tartarin, consequently 100 parts of this salt should contain 64,7 of alkali, and 35,3 of acid, and 100 parts tartarin should take up 54,491 of real acid, and afford 154,491 of muriated tartarin, all which determinations differ very little from mine, and afford no inconsiderable proof of the accuracy of the table.

Hence we may deduce the quantity of real acid in Wenzel's sp. of salt and its sp. gravity.

By his own account 202 grains of his sp. of salt contained 45,5 of his strongest acid, consequently 100 grains of it should contain 22,52, and 240 grains of it 54, and its sp. gravity about 1,174.

By my calculation 202 grains of his sp. of salt contained 46,44 of my real acid, and 100 grains of it contained nearly 23 of my real acid, and 240 of it contained 55,17, and its sp. gravity should be about 1,176.

Another proof of the accuracy of my determinations will be found in the 2d §.

Klaproth's determination agrees fully with mine, for to 116 grs. of sylvian he ascribes 42 of concentrated muriatic acid, consequently 100 grains of sylvian should contain 36,2. 1 Klapr. 134.

Section

Section 2d.

COMMON SALT.

IT has been ſeen in my laſt paper that 30,05 grains of mere ſoda were ſaturated by 129 grains of muriatic acid or ſp. of ſalt, whoſe ſp. gravity in the temperature of 60° was 1,1355; this by the table contains about 17,5 real acid per cent. conſequently 129 grains of it contained 22,07 grains real acid, if therefore the neutral ſalt here formed contained nothing elſe but mere ſoda and real acid, its weight ſhould be 30,05 + 22,07 = 52,12. Yet by the laſt experiment it appeared that the weight of the ſalt thus formed amounted to 56,74 gr. the ſurplus 4,62 grains muſt therefore have been water, and ſince 56,74 grains of common ſalt contain alkali, real acid and water in the above proportions, 100 grains of common ſalt (well dried and deprived of the water interſperſed between its pores) muſt contain 52,96 ſoda, 38,88 real acid, and 8,16 water of compoſition that always accompanies the acid when this ſalt is formed, and therefore muſt in all other ways of examining the compoſition of this ſalt, have been confounded with it. In this ſenſe therefore I may ſay that 100 parts common ſalt contain in round numbers 53 parts alkali and 47 of acid.

HENCE 100 parts mere ſoda take up 73,41 of real marine acid, or 88,74 of the aqueous acid, and then afford 188,74 of common ſalt. And 100 parts of the aqueous acid ſhould take up 112,688 of

of ſoda, and afford 212,688 of common ſalt, and 100 grains real marine acid ſhould take up 136,31 of ſoda, and afford 257,2 of common ſalt.

100 grains of the aqueous acid contain 15,33 of water.

According to Wenzel 131,5 of ignited common ſalt contain 71,5 of alkali, and 60 of his ſtrongeſt marine acid; conſequently 100 grains common ſalt ſhould contain 54,3 of alkali, and 45,7 of that acid. And 100 parts mere ſoda ſhould afford 184 nearly of ignited common ſalt. This ſtatement differs very little from mine, and from Weigleb's ſtill leſs, for he found 100 parts common ſalt to contain 53,5 of alkali, and 46,5 of acid, and 100 parts ſoda ſhould take up 87,5 of acid, and afford 187,5 of common ſalt.

But Mr. Bergman's ſtatement differs widely from the foregoing, both Wenzel and I have found the alkaline part to exceed the acid, he on the contrary found the acid to exceed by much the alkaline, for to 100 parts common ſalt he aſſigns 52 of acid, 6 of water and only 42 of alkali. From the great reſpect I have ever entertained for this excellent man, this circumſtance always gave me much uneaſineſs. To inveſtigate the truth by direct experiment otherwiſe than was always done appeared difficult. I therefore endeavoured to diſcover it by an *indirect* experiment, namely, by finding how much cauſtic ſoda might be obtained from the decompoſition of a given quantity of common ſalt, this decompoſition

decompoſition I effected by tartarin, but the exact ſeparation of the ſoda from the ſylvian was ſo difficult that I deſpaired of obtaining ſatisfaction in that w y: luckily, however, a more patient and ſkilful experimenter, Mr. Hahneman has ſince performed this experiment, and found that 11 parts mere tartarin were requiſite to ſeparate 7 of *mere* ſoda from common ſalt * We may therefore now examine with which of the two oppoſite ſtatements this proportion is beſt ſuited.

By my determination 7 grains ſoda enter into the compoſition of 13,21 of common ſalt, and this quantity of common ſalt contains alſo 5,13 grains real acid, which muſt be taken up by the tartarin to ſet the 7 grains of ſoda free. Now ſince 100 parts tartarin take up 56,3 of real marine acid, 9,12 of tartarin ſhould take up 5,12 of this acid, which falls ſhort of Hahneman's reſult by 1,88 grains. But it is well known that ſomewhat more of any divellent agent muſt be applied to effect an *intire ſeparation* of any principle than would be neceſſary to ſaturate that principle if it were in a free diſengaged ſtate.

By Bergman's determination 7 grains of ſoda enter into the compoſition of 16,66 of common ſalt, and this quantity of common ſalt contains alſo 8 of real marine acid, now, as according to him 100 parts tartarin take up 51,5 of the ſtrongeſt or real marine acid, 15,53 would be requiſite to take up 8 of that acid, which exceeds Hahneman's reſult by 4,53 grains, whereas by the above reaſon it ſhould rather fall ſhort of it.

 But

* 2 Chy. An. 1797, p. 396.

But there are two other experiments which ſet the inaccuracy of his determination in a ſtill clearer light, the one executed by Mr. Wolfe, aud the other by Dr. Black †.

Mr. Wolfe found that 120 parts muriated ſilver or luna cornua, when decompoſed by tartarin, afforded 55 grains of ſylvian or muriated tartarin; theſe 55 grains therefore contained all the acid that exiſted in 120 of muriated ſilver. Now Dr. Black found that 235 grains of muriated ſilver contain all the acid that exiſts in 100 grains of common ſalt, and conſequently 120 grains of the muriated ſilver contain all the acid that exiſts in 51,06 of common ſalt, whence it follows that 55 grains of ſylvian and 51,06 of common ſalt contain the *ſame quantity of acid*, ſince the firſt received and the latter gave out all the acid that exiſts in 120 parts muriated ſilver.

We may now ſee in which of the 2 different ſtatements this equality is found, or whether in neither or in both.

1ſt. According to Bergman 100 grains of muriated tartarin contain 31 of real acid, then 55 grains of that ſalt ſhould contain 17,05.

Again, 100 grains of common ſalt contain by his ſtatement 52 of real acid, then 51,06 of this ſalt ſhould contain 27,55; theſe quantities are evidently very diſtant from an equality.

2d.

† Phil. Tranſ. 1776, p. 611. 3 Edinb. Tranſ. 116.

2d. By my ſtatements 100 parts ſylvian contain 36 of real acid, then 55 parts of this ſalt ſhould contain 19,8; alſo 100 parts common ſalt contain 38,88 real acid, then 51,06 parts of this ſalt ſhould contain 19,85.

Section 3d.

MURIATED BARYTES.

The proportion of ingredients in this ſalt may be inveſtigated from the following facts:

1ſt. Klaproth found that 73 grains of aerated native barytes (which contained an inconſiderable proportion of ſtronthian) ſaturate 100 grains of muriatic acid, whoſe ſp. grav. was 1,140 diluted with 200 grains of water, and that 100 grains of aerated barytes contain 22 of fixed air, 2 Chy. An. 1793, p. 195 and 196, and 1 Klapr. 269, therefore 73 grains of aerated barytes contain 56,94 of barytic lime.

2dly, He found that 56,59 pure aerated barytes diſſolved in this acid afforded 6850 of cryſtallized muriated barytes. 2 Klapr. 84.

Then 100 grains of aerated barytes, or 78 of mere barytes, would give 21,04 of muriated barytes. And 100 grains of mere barytic earth ſhould give 155 nearly of cryſtallized muriated barytes.

According to Fourcroy, 4 An. Chy. 71, 100 grains native barytes afford but 112 of deſiccated muriated barytes; yet Pelletier

tells us, that 100 grains native aerated barytes afforded him 138 of cryſtallized muriated barytes, but moſt probably it retained ſome of the mother liquor.

Hence I deduce, 1ſt, that as 100 grains muriatic acid, 1,140 contain 18,11 real acid, 56,94 of barytes took up that quantity.

Consequently 100 *grains mere barytic earth* take up 31,8 of real marine acid, and afford 155 of cryſtallized muriated barytes.

And 100 *grains real marine acid* ſhould take up 314,46 of barytes.

We may alſo remark, that the muriatic acid whoſe denſity is 1,140, being mixed with twice its weight of water, will have its ſp. grav. 1,0427 which is nearly the ſame as that which Fourcroy found beſt adapted to ſuch ſolution, namely, 1,0347; and perhaps if the temperature were equal would approach each other ſtill more nearly. It appears then that the real acid ſhould be accompanied with 16 times its weight of water.

2dly, It follows, that 121,04 parts cryſtallized muriated barytes contain 78 earth, 24,8 acid, and 18,24 water, conſequently 100 *parts of the cryſtallized* ſalt contain 64,44 earth, 20.45 acid, and 15,06 water.

And 100 *grains of the deſiccated* contain about 70 of earth, 22 of acid, and 8 of water.

(Per

(Per Crawford, quoted by Schmeiffer in Phil. Tranf. 179, 421, muriated barytes is nearly as foluble in hot as in cold water, and three times lefs foluble than muriated ftronthian.)

To confirm this conclufion I muft add, that having precipitated a folution of 100 grains of cryftallized muriated barytes by a folution of nitrated filver, I found the precipitate duly dried to weigh 118 grains, which as we fhall prefently fee argues the prefence of 19,51 of real marine acid. I alfo found that 100 parts muriated barytes expofed to a heat of 300° for two hours, loft 16 grains of water of cryftallization, hence we may rate in round numbers the proportion of ingredients in this falt, at 64 of earth, 20 of acid, and 16 water of cryftallization.

Section 4th.

Muriated Stronthian.

Klaproth obferved, that 55 grains of native mild ftronthian faturated 100 of marine acid, whofe fp. grav. was 1,140, this being diluted with 50 grains of water, 100 grains marine acid of this fp. grav. contain, computing from my table 18,11 grains of real acid, and 55 grains mild ftronthian, (at the rate of 69 per cent.) contain 37,95 of mere earth.

Hence

Hence I conclude, that 100 grains mere ſtronthian earth take up 47,79 of real acid (ſince 37.95 take 18.11 of real acid) and would afford, as we ſhall preſently ſee, 254.84 of cryſtallized muriated ſtronthian, or 147,79 of deſiccated ſtronthian*.

And 100 grains real marine acid enter into the compoſition of 209 grains of deſiccated ſtronthian, or of 360 of the cryſtallized.

Again, Dr. Hope found, that 100 *grains cryſtallized muriated ſtronthian* contain 42 *of water of cryſtallization*, and conſequently 58 of deſiccated which contain earth and acid in the proportion above mentioned (or 100 earth to 47,79 acid) that is, 39,24 of earth and 18,76 of acid, this proportion agrees very exactly with that obſerved by Pellitier †, for he found 100 grains of native aerated ſtronthian (which contain 69 of earth) to afford 176 of cryſtallized muriated ſtronthian.

And ſince, in Dr. Hope's experiment, 39,24 of this earth afforded 100 grains of muriated ſtronthian, 69 ſhould afford 175,8. Some experiments however of Mr Lowitz vary conſiderably from the above ſtatements, it appeared to him that in muriated ſtronthian the quantity of acid exceeded that of earth in the proportion of 54 to 46 ‡; if ſo, 100 grains of muriatic acid of the ſp. grav. 1,140 ſhould contain 44,54 of real acid, for it took up 37,95 of earth

* 2 Chy. An. 1793, p. 194. † 21 An. Chy p. 128. ‡ 1ſt. Chy. An. 1796, p. 128, 129.

earth in Klaproth's experiment already quoted, which is inconfiftent with the proportion of real acid. I have found in muriatic acid in a multitude of experiments, and contrary to all analogy, as we fee that by barytes and fixed alkalis betwixt which this earth undoubtedly ftands, take up lefs than their own weight of real marine acid: it is alfo contradicted by Pellitier's experiment, for fince 100 grains native aerated ftronthian contain 69 of earth, thefe at the rate of 46 to 54 fhould take up 80 grains of real muriatic acid, and the fum of both would be 149 grains: and fince by Dr. Hope's experiment 58 grains of united earth and acid take 42 grains of water of cryftallization, 149 grains fhould take 107; and hence inftead of 176 grains of cryftallized muriated ftronthian we fhould have 256 grains from 100 of aerated ftronthian.

Klaproth informs us, that from a folution of 100 grains of aerated ftronthian in muriatic, precipitated by the addition of concentrated vitriolic acid, as long as any precipitate appeared, he obtained no more than 114 grains of vitriolated ftronthian, and that dried only in air*; whereas the precipitate fhould amount, if the whole of it were obtained, to 118 grains; for fince 58 grains of this earth, as he elfewhere relates, † afford 100 of vitriolated ftronthian, 69 fhould afford 118; it is plain therefore that the ma-

rine

* 2 Chy. An. 1793, p. 200. † 2 Klapr. p. 97.

rine acid retained ſome, or that a ſufficiency of the vitriolic acid was not added. This earth is not therefore a proper teſt of vitriolic acid, at leaſt not as proper as the barytic.

To obtain a leſs circuitous proof of the proportion of ingredients in 100 parts of this ſalt, I precipitated a ſolution of 100 grs. of cryſtallized muriated ſtronthian by mild ſoda; the precipitate after ignition weighed 56,75 grains, but theſe being diſſolved in marine acid gave out 17 grains of fixed air, and therefore contained only 39,75 of mere earth.

2dly. I precipitated a ſolution of another 100 grains of this cryſtallized ſalt by a ſolution of nitrated ſilver, and found the precipitate duly dried to weigh 110 grains, a weight which indicates the preſence of 18,19 grains real marine acid. The weight of the 3d ingredient, namely water, muſt therefore amount to 42,06 grains nearly, as Dr. Hope has ſtated.

Hence we may rate the proportion of ingredients in 100 parts of this ſalt at 40 of earth, 18 of acid, and 42 of water. And to 100 parts of the deſiccated ſalt we may allow about 69 of earth and 31 of acid.

Hence 100 *parts ſtronthian earth* take up 45 or more, exactly 46 of real marine acid, and ſhould *afford* 250 of cryſtallized, or 145 of deſiccated muriated ſtronthian. And 100 *parts real marine acid*

acid ſhould take 222, or more exactly 216,21 of ſtronthian earth, and *afford* 540 of cryſtallized, or 313,5 deſiccated muriated ſtronthian.

Section 5*th*.

MURIATED LIME.

IN my experiment already mentioned 158 grains of powdered Carrara marble were ſaturated by 402 of muriatic acid, whoſe ſp. grav. was 1,1355, which contained 17,5 per cent. real acid; therefore 402 grains of it contained 70,55 real acid. The 158 grains marble (at the rate of 53 per cent.) contained 83,74 of lime. Then 83,74 grains lime took up 70,55 of real marine acid. To effect a ſaturation a heat of 160° was employed towards the end of the ſolution.

HENCE 100 *grains of lime* would ſaturate 84,488 of real marine acid. And 100 *grains real marine acid* would ſaturate 118,3 of lime.

IN Wenzel's experiment the acid was not ſaturated, and hence the reſult differs from that of mine. To 240 grains of his ſp. of ſalt he added 120 grains of fragments of purified oyſter-ſhells (which, as we have already ſeen in treating of ſelenite, contained 52,8 per cent. of lime,) and at the latter end expoſed them

to a gentle heat, and when no ſenſible ſolution appeared he ſeparated what remained undiſſolved, and found that after waſhing and drying it, it weighed 19,625 grains; hence he concluded that 100,375 grains of theſe ſhells were diſſolved; but then he had no reaſon to think the acid was ſaturated, or that in a longer time it would not take up more, eſpecially as the ſhells were not in a fine powder, nor did he apply any teſt as I did. Having evaporated the ſolution to dryneſs and heated the dry maſs to fuſion, he found it to weigh whilſt ſtill red hot 106,125 grains.

THIS ſhews the ſolution not to have been ſaturated, for 100,375 grains of the ſhells contained 53 of lime, and the 240 grains ſp. of ſalt contain 54 of real acid by his own account; therefore, as ſaturated muriated lime loſes no acid in a melting heat, the ſalt ſhould weigh even by his eſtimation 107 grains, and by my calculation 112 grains; the remainder therefore of the unſaturated acid was expelled by the heat of fuſion.

ACCORDING to him 100 grains lime ſhould take up 102 grains of the ſtrongeſt marine acid.

IT muſt be remarked, alſo, that this ſalt though in a melting heat ſtill retains ſome water, and Wenzel's experiment ſhews how much; for by my determination 53 grains lime take up only 44,75 of real acid; and the ſum of the ingredients in Wenzel's experiment amounts only to 97,75 grains; yet he found the weight 106,125; then 8,375 grains were water.

THEN

THEN 100 grains muriated lime, weighed red hot, contain nearly 50 of lime, 42 of acid and 8 water.

BERGMAN agrees with me ſo far as ſtating the proportion of lime in this ſalt to be ſuperior to that of acid; to 100 parts of this ſalt he aſſigns 44 of lime and 31 of acid, but the proportion of acid is higher, for to 44 of lime 37 of acid appertains, by the proportion above ſtated then that of water is 19.

Note. His ſalt was weighed at far a lower temperature than Wenzel's, and hence the quantities but not the proportions in 100 grains of it are altered, as it powerfully attracts water.

Section 6th.

MURIATED MAGNESIA.

THE proportions of acid and baſis in this ſalt are difficultly determined, as it powerfully attracts moiſture and eaſily loſes its acid if ſtrongly heated, and without ſuch heat will retain much water.

IN my experiments it appeared that 100 grains mere magneſia took up 215,8 of ſtandard, or 111,35 of real marine acid.

AND 100 grains real marine acid take up 89,8 of mere magneſia.

KLAPROTH * found 420 grains of muriated magnesia evaporated to dryness to contain 290 of magnesia; as it was precipitated by soda he probably meant mild magnesia, which generally contains but 0,45 of earth; if so, 290 contained but 130,5 of mere magnesia; consequently 100 grains of muriated magnesia gently but sensibly dried should contain 31,07 mere magnesia, and this by my computation should take up 34,59 of real acid. The remainder is therefore water.

WENZEL's experiments accord with mine with respect to the superiority of the proportion of earth to that of acid in a given weight of muriated magnesia. According to him 100 grains of mere magnesia take up 122 of real marine acid; but by my computation of the quantity of real acid in his sp. of salt, *v. z.* 23 per cent. allowing his mild magnesia 45 per cent. of earth, 100 grains of it should take up 115,8 real muriatic acid.

BERGMAN's results differ from these very widely, for according to him 41 grains mere magnesia take up only 34 of the strongest marine acid.

Section

* 1 Klapr. 369.

Section 7th.

MURIATED SILVER.

IT is now well known from the experiments of Margraff, Bergman, Klaproth, Wolfe, Wenzel, &c. to which I need not add my own, that 100 grains of muriated ſilver contain very nearly 75 of ſilver when dried in a heat of 80°, or 75,235 when heated more but not fuſed, as in Wenzel's and Wolfe's experiments; but it muſt not be inferred that the remaining 25 grains are mere marine acid, for ſilver diſſolved in nitrous acid takes up 10,8 per cent. of oxygen; therefore 75 grains of it take up 8,1, which ſubſtracted from 25, leaves the quantity of acid 16,9; or if the muriated ſilver were much heated, the acid and oxygen would amount only to 24,76; and deducting the oxygen, the acid ſingly would be 16,6 grains; this agrees exactly with Wolfe's experiment, for he found as already ſaid that 120 grains of this metallic ſalt decompoſed by tartarin afford 55 of muriated tartarin. Now 120 grains contain by this computation 19,92 of real acid; and as 100 grains muriated tartarin contain 36 of real acid, 55 grains of it ſhould contain 19,8; the difference is inſignificant.

HENCE 100 grains ſilver take up 22,133 of real marine acid, and afford 133 of muriated ſilver by the addition of oxygen.

AND 100 grains real marine acid unite to 451,87 of ſilver, and afford 602,4 of muriated ſilver.

100

100 grains pure cryſtallized common ſalt precipitate from a ſolution of nitrated ſilver 233,5 grains of muriated ſilver by Klaproth's, 235 by Dr. Black's, and 237 by Arrhenius's experiments *; Dr. Black's is a medium between both; the difference ariſes only from the degree of deſiccation.

100 grains of muriated tartarin ſhould produce 216,86 of muriated ſilver.

Section 8th.

Muriated Lead.

This ſalt may be obtained in two ſtates, either in acicular cryſtals or thoroughly deſiccated. The proportion of ingredients in each I deduce from the following facts:

1ſt. Klaproth having diſſolved 100 grains lead in dilute nitrous acid, and precipitated the lead by cauſtic tartarin, found the precipitate ſharply dried until it began to grow yellow, to weigh 115 grains. 1 Klaproth, 274.

2d. Having precipitated a ſolution of 100 grains of lead in nitrous acid by dropping muriatic acid as long as any precipitate appeared, and evaporated the whole to dryneſs in a ſand heat, he found the muriated lead to weigh 133 grains. Ibid.

3d.

* Mem. Stock. 1785.

3d. HE alſo found that 22,5 grains of cryſtallized acicular muriated lead, well drained and dried by expoſure to the air, contained 16 grains of metallic lead, therefore 100 grains of ſuch cryſtals ſhould afford 71,11 of metallic lead.

FIRST, to theſe facts I muſt farther add, that in muriated lead, whether cryſtallized or deſiccated, the lead is in a calcined ſtate.

HENCE I infer, that ſince 100 grains of metallic lead give 133 of calx of lead, the 71,11 grains of metallic lead in 100 parts cryſtallized muriated lead amount to 81,77 of calx of lead. The calx, including not only the metallic lead, but alſo oxygen and water, as we ſhall preſently ſee; the remainder therefore is real marine acid, amounting to 18,23 grains.

AGAIN, as 133 grains of the thoroughly deſiccated muriated lead contain 100 of metallic lead, 100 grains of this muriated lead muſt contain 75,12, but 75,12 metallic lead form 83 of calx; the remainder therefore muſt be real marine acid = 17 grains.

THESE concluſions are farther confirmed by the experiment of Mr. Wolfe. Phil. Tranſ. and 10 Roz. 370. Having decompoſed 120 grains of muriated lead dried by expoſure to the air by a ſufficient quantity of tartarin, he found them to produce 61 grains of muriated tartarin. Therefore both the 120 grains muriated

riated lead and the 61 grains of muriated tartarin ſhould contain the ſame quantity of real marine acid. Now if 100 grains muriated lead dried in air contain 18,23 real acid, 120 grains of it ſhould contain 21,87 real acid.

AND ſince 100 grains muriated tartarin contain by my former determination 36 grains real acid, 61 grains of this ſalt ſhould contain 21,96; the difference is only 0,09 of a grain.

As to the 115 grains calx of lead produced in the precipitation of a ſolution of 100 grains of lead in nitrous acid by cauſtic tartarin, I have already ſhewn in the 2d vol. of my Mineralogy, p. 497, that 100 parts lead, when diſſolved in nitrous acid, take up 5,8 of oxygen*, therefore the remainder is water, = 9,2 grains.

HENCE 100 parts metallic lead take up about 25,63 of real marine acid, and afford 140,62 of cryſtallized muriated lead, or 133,12 of the deſiccated.

AND 100 grains real marine acid unite to 394,06 of metallic lead, and afford 548,64 of cryſtallized muriated lead.

AND

* Fourcroy, 2 An. Chy. 213, ſtates the quantity of oxygen at 12,5 in 100 of muriated lead, but this is contradicted by the experiment of Mr. Wolfe, &c. He moſt probably means the muriated lead formed in the ſolution of a calciform ore.

And 100 parts cryſtallized muriated lead contain 81,77 calx of lead (= 71,11 metallic lead,) and 18,23 of real marine acid.

And 100 grains thoroughly deſiccated muriated lead contain 83 calx of lead (= 75,12 metallic lead,) and 17 of real marine acid.

According to Wenzel, 100 grains metallic lead ſhould afford 137,5 of deſiccated muriated lead; he probably dried it ſomewhat leſs than Klaproth had done. The proportions of lead and acid he could not well determine, the exiſtence and proportion of oxygen not being known when he wrote.

Note. The quantity of metallic lead obtained from 100 parts cryſtallized muriated lead by fuſion with black flux is much ſmaller than that above ſtated. (ſee 1 Klapr. 171,) as much is retained by that flux. Yet ſee 3 Weſtrumb. Phyſical and Chem. Abhandl. 383.

Of Aerated Vol-Alkali and Ammoniacal Salts.

The former experiments which I made with a view of aſcertaining the proportion of ingredients in theſe ſalts were defective in ſeveral reſpects:

1ſt. For want of a due eſtimate of the quantity of mere vol-alkali in a given quantity of aerated alkali, the ſubſtance to be ſaturated with the three other mineral acids. Dr. Prieſtly's experiments, the baſis of the eſtimate I then formed, not exhibiting the temperature and preſſure of the atmoſphere when the volumes of fixed and alkaline airs were combined, afforded an opportunity for forming rather an approximation than an accurate determination of their ſeveral weights.

2d. I was not then aware of the difficulty of finding the exact point of ſaturation of the aerated vol-alkali with the mineral acids; a difficulty however mentioned by Macquer *, and ſo great that Du Hamel judged it impoſſible to vanquiſh it †. Wenzel very ſagaciouſly abſorbed the exceſs of acid by oyſter ſhells, but in my mode of experimenting this teſt could not be applied; hence there was an exceſs of acid in all of them. Theſe errors induced me to analyze rather than compoſe theſe ſalts.

Of Aerated Vol-Alkali.

By diſtilling 100 grains of aerated vol-alkali with 300 of dry ſlacked lime in a pneumatic apparatus and a ſand heat I obtained 129 cubic inches of alkaline air, barometer 30,2, and thermometer

at

* Macquer's Elem. 389, Engliſh. † Mem. Par. 1735, p. 664, in 8vo.

at a medium 62,5. 100 grains of alkaline air weigh 18,16 grains, as I have ſhewn in a former treatiſe, barometer 30, thermometer 61. Then at that barometrical height 129 cubic inches would become 130; but as the heat in the preſent experiment exceeded 61, the expanſion reſulting from it muſt be ſubſtracted; and according to Mr. Morveau, 2 An. Chy. a volume of this air at 32° being taken as 1 becomes at 77° 1,2791, and conſequently gains 0,0062 by each intermediate degree, conſequently the volume of this would at 61 be only 129,1; its weight therefore is nearly 24 grains. This ſalt contained 52 per cent. of fixed air, conſequently its ingredients were 52 grains fixed air, 24 of mere alkali, and 24 of water.

The proportion of vol-alkali in aerated vol-alkalis vary, increaſing or decreaſing with the proportion of fixed air they contain.

Mr. Cavendish in the Philoſophical Tranſ. for 1766, p. 169. found that 1643 grains of aerated vol-alkali, containing 53,8 per cent. of fixed air, ſaturated the ſame quantity of marine acid as 1680 of another parcel, which contained but 52,8 per cent. of fixed air.

Hence the quantities of mere alkali in each were reciprocally as 1680 to 1643, and theſe are nearly to each other as 53,8 to 52,8; and as the aerated vol-alkali that contained 52,8 per cent. of fixed air contained 24 per cent. of mere vol-alkali; that which contained 53,8 per cent. of fixed air ſhould have contained 24,83 per cent.

HENCE the *proportion of fixed air in aerated vol-alkalis is* to that of mere alkali in thofe falts *as* 13 *to* 6, and the remainder is water of compofition.

WENZEL, p. 100, alfo perceived that the proportion of mere alkali in aerated vol-alkali was very fmall, and ftates it nearly as low as I do; for to 240 grains of this falt, containing 53,75 per cent. of fixed air he afcribes 129 of fixed air, 31,125 of water, and confequently 79,875 of mere alkali. Hence 100 grains fhould contain 53,75 fixed air, 33,28 of alkali and 12,97 of water.

COMMON SAL AMMONIAC.

BY diftilling in a pneumatic apparatus and a fand heat, 100 grains of fublimed fal ammoniac and 300 grains of quick lime, I found it to yield as much alkaline air as amounted to 25 grains, with fome few drops of water; the remainder of the water being probably detained by the lime or by the muriated lime which is known to retain water moft obftinately.

BY treating 100 parts of this falt in folution with a folution of nitrated filver, I found it to afford 258,5 of muriated filver heated to fufion, and confequently to contain 42,75 of real marine acid.

HENCE

Hence 100 parts of this salt contain 42,75 of real marine acid, 25, or making allowance for losses, 28 of mere vol-alkali, and 29,25 of water of crystallization and composition.

Hence 100 parts mere vol-alkali take up 152,68 of real marine acid, and should afford, if there were no loss, 357,14 parts of sublimed sal ammoniac. And 100 parts marine acid take up 65,4 nearly of mere volalkali, and should afford 233,9 parts of sublimed sal ammoniac; but in subliming sal ammoniac there is always some loss.

Mr. Cavendish, in the Philosophical Transactions for 1766 tells us, that 168 parts aerated vol-alkali, containing 52,8 per cent. of fixed air, saturated as much marine acid as 100 grains of marble, which contained 40,7 per cent. of fixed air; now 100 grains of this marble contain, by the analogy formerly given, (45 of fixed air to 55 of lime) 50 grains of lime, by the 2d table, take up 42,2 of real marine acid, and 100 grains of the aerated vol-alkali there mentioned, contain 24 per cent. of mere alkali, and consequently 168 grains of it should contain 40 of mere alkali, which by the above statement would require for saturation 61 of real marine acid. This experiment would have made me doubt of the propriety of the above conclusions, had not Mr. Cavendish expressly stated that his solution of marble was saturate, (and consequently as a saturate solution cannot be obtained without heat, which he did not apply, he must have added an excess of marble, and judged the solution

ſolution ſaturate when no more air was expelled) and on the other hand he tells us, that the alkaline ſolution contained an exceſs of acid, and this exceſs exiſting in every particle of a large ſolution muſt be conſiderable.

In the experiment related in my laſt paper, I ſtated that 100 grains of aerated vol-alkali were ſaturated by 246 of marine acid, whoſe ſp. grav. was 1,1355, which appears by the firſt table to contain 17,5 per cent. real acid, and conſequently the quantity in 246 grains was 43 grains; on the other hand, the vol-alkali, containing but 43 per cent. of fixed air, contained, by my actual experiments, only 19,85 grains of mere alkali, and this quantity ſhould take up but 30 of real marine acid. Hence in my former experiments there was an exceſs of 13 grains of acid, which made the ſp. grav. equal to that of the teſt ſolution, and thus induced me to think the quantity of ſal ammoniac formed greater than it really was.

Wenzel found 168,4 grains of vol-alkali, containing 53,75 per cent. of fixed air, to require 240 grains of his ſp. of ſalt to ſaturate them, and this quantity of his marine acid we have already ſeen to contain 55,17 of real acid, and 168,4 of the aerated alkali contained, by the analogy already ſtated, 41,71 of mere vol-alkali, the ſum of both was 96,88; yet having evaporated the ſolution to dryneſs, and expoſing the reſiduum to a heat of 212° for four hours, he found

found it to weigh 110,125 grains, as he knew 55 of thefe to be acid (or according to him 54), he naturally fuppofed the remainder to be vol-alkali; hence according to him 100 parts of fal ammoniac thus dried contain 49 parts of acid and 51 of vol-alkali. The difference between us feems to arife from the lofs always experienced during evaporation, and if this had not happened, the dry refiduum would have amounted to 128 grains; as to the quantity of vol-alkali he had no method of eftimating it.

CORNETTE perfectly decompofed 2304 grains of fal ammoniac by an equal quantity of lime, which he flacked after weighing it, examining the refiduum, he threw it on a filter, and edulcorated it with repeated effufions of water, and what remained undiffolved he found to weigh, when dry, 756 grains, and hence he judged the remainder, viz. 1548 grains to have been diffolved by the acid of the fal ammoniac, and to confirm this conclufion, he precipitated the folution which had paffed the filter with a fixed alkali, and drying the precipitate, found it to weigh 1542 grains*; whence it feems to follow, that the acid contained in 2034 of fal ammoniac had diffolved 1542 of lime, whereas, by my calculation, it fhould diffolve but 1272,46 of lime, for fince 100 grains of fal ammoniac contain 42,75 of real marine acid, 2304 fhould contain 1008; and fince by the third table 100 grains real marine acid take up 118,3 of lime, 1008 fhould take up but 1272,46 of lime.

BUT

* Mem. Par. 1786, p. 533.

But the lime I used was pure and perfectly free from fixed air; can that be said of the common lime of Marly, which he employed and does not say he had prepared? Besides, by his edulcorations, much pure lime must have been dissolved, and have mixed with the solution of muriated lime, and if his alkali were not caustic, the quantity of lime precipitated by it must have been at least partially aerated, and consequently the mere earthy part apparently greater than it would have been if pure. However, as this experiment forms a cumulative proof both of the proportion of acid contained in sal ammoniac, and of the quantity of it taken up by a given weight of lime, I thought it incumbent upon me to repeat it, hence I mixed 50 grains of sal ammoniac with 150 of slacked lime, and heated the mixture in a large glass phial until all the alkali was driven off and the mixture ceased to smell, I then added a sufficient proportion of water, and digested the whole in a gentle heat for some hours, then filtered and edulcorated the mass on the filter, as I judged the solution to contain lime as well as muriated lime, I passed a stream of fixed air into it, which instantly turned it milky, and then filtered it off; the solution now free from lime I precipitated by a solution of an aerated soda, which contained 17 per cent. of fixed air, as much of the solution was requisite as contained 123 grains of soda. The precipitate collected, edulcorated and dried for some hours on the filter, in a heat of 150°, weighed 46,75 grains, though no more could be separated than 41,62, these after ignition weighed 35 grains, some stuck to the glass

glafs, and 5,25 remained in the filter; 123 grains of the foda gave out 20,91 of fixed air, and, as I afterwards found, kept about a a grain of the lime in folution, now 21 grains of fixed air are abforbed by 23,44 of lime, this then was the quantity of lime taken up by the acid contained in 50 grains of fal ammoniac, that is, 21,37 real marine acid, whereas by my calculation, fince 100 grains marine acid take 118,3 of lime, 21,37 fhould take up 25,28, the difference is 1,84 grains, and even this I believe to proceed from the whole of the fal ammoniac not having been decompofed, 19,8 grains of the acid appear to have been taken up by the lime, and about 3,6 of the ammoniac efcaped decompofition, this alfo clearly appears by the action of the foda, for 100 grains of this foda contain 22 of mere alkali, then 123 grains of it contains 27; as 100 grains mere mineral alkali take up 73,41 of marine acid, then 27 fhould take up 19,82.

Hence we fee that in Rigour 100 parts fal ammoniac may be decompofed by 100 parts chalk, for 100 parts chalk generally afford 42 of fixed air, and confequently contain 51,3 of lime, and 100 parts fal ammoniac contains 42,75 real acid, and fince 100 grains real marine acid are faturated by 118,3 of lime, 42,75 of this acid require but 49,57 of earth; but in all fuch cafes the medium of decompofition is always taken in greater quantity than is abfolutely requifite, otherwife the mixture would never be perfect, and in this cafe part of the falt might fublime without decompofition; hence 200 parts chalk are moft commonly ufed,

 though

though 125 are ſaid to be ſufficient. *Doſſie Elab. laid open* 110, 1 *Labor. in Groſs* 68, in note per *Weigleb.* and in effect 125 grains chalk, at the above rate, would furniſh 52 grains of fixed air, which would ſaturate 24 of vol-alkali, and the ammoniac contains a ſufficiency of water.

Hence alſo we ſee how it happens that 100 parts ſal ammoniac decompoſed by 200 parts chalk frequently afford 89, nay, according to Baumé, even 94 parts aerated vol-alkali, for if there were no loſs 125 parts of chalk were ſufficient, but then this large quantity of fixed air is expelled, not by the acid of the ſal ammoniac, but by the heat applied, as Pellitier de la Sale has noticed, 2 Pharmacopie de Londres 427, and on this account magneſia, as it parts with its fixed air much more eaſily, and contains more water, affords a quantity of aerated vol-alkali, when uſed as a medium for decompoſing ſal ammoniac, nearly double that of the ſal ammoniac employed. Thus Weſtrumb from 100 grains of ſublimed ſal ammoniac and 300 of magneſia obtained 193 grains aerated vol-alkali, 2 Chy. An. 1788, p. 15; his magneſia muſt have contained a very large proportion both of fixed air and water, for he ſays that 1920 grains of it being calcined left only 600 of earth, ibid. 17.

Hence alſo, Dolfuz having treated 100 parts ſal ammoniac with 125, and even with 200 of chalk, in a glaſs retort, obtained no more than 50 of aerated vol-alkali; the ſame thing happened when he

he ufed an earthen retort, as he fimply heated it to rednefs, whereas a ftrong white heat is requifite to expel fixed air from chalk, 2 Crell. Beytr. 199 I believe unpurified fal ammoniac would yield more aerated vol-alkali than the purified, on account of the oil it contains, which affords fixed air. Another certain proof that 125 grains chalk are not acted upon by the acid contained in the 100 parts fal ammoniac, but contribute to the increafed quantity of aerated alkali merely by the fixed air expelled from them by heat, is that the refiduum contains fome calcareous earth which the acid had not attacked, as Richter has obferved, 1 Stock. 2 Theile 98 and 99.

SEVERAL important deductions may be deduced from the knowledge of the compofition of fal ammoniac, for inftance, an eafy explanation of its great refrigerating power, &c. which being improper for this place, I omit.

VITRIOLIC AMMONIAC.

100 grains of cryftallized vitriolated vol-alkali and 300 dry flacked lime, pneumatically diftilled in a pneumatic apparatus and a ftrong fand heat, Bar. 30,2, Therm. 66°, afforded 78,41 cubic inches of alkaline air, = 14,24 grains.

From a ſolution of vitriolated vol-alkali, precipitated by a ſolution of muriated barytes, 164 grains of ignited baroſelenite were obtained, hence the ſalt contained 54,66 grains real vitriolic acid.

Hence 100 grains vitriolated vol-alkali contain 14,24 of mere vol-alkali, 54,66 of real acid, and 31,1 of water.

In my former paper I ſtated the quantity of vitriolic acid in 100 grains of cryſtallized vitriolated vol-alkali to be 62,47 ſtandard, = 55,7 real acid, the variation is not conſiderable, but of the alkali I could not then form a proper eſtimate.

Hence 100 parts mere vol-alkali take up 383,8 of real vitriolic acid, and *afford* 702,24 of vitriolated volalkali.

2dly, 100 parts real vitriolic acid ſhould take up 26,05 of mere vol-alkali, and *afford* 182,94 of vitriolated vol-alkali.

According to Wenzel, alſo, 100 parts vitriolic ammoniac contain 58,8 of real acid, hence of all cryſtallized ſalts it contains the greateſt proportion of this acid, as Glauber does the leaſt.

Nitrated Vol-Alkali.

From 50 grains of cryſtallized nitrated vol-alkali, mixed with twice its weight of ſlacked lime, I obtained, in a pneumatic apparatus, 40 cubic inches of alkaline air, Bar. 30,06, Therm. 61°, by

by the ſimple heat of a candle; ſome water alſo paſſed, which undoubtedly abſorbed ſome air, a greater heat could not be applied without riſking a decompoſition of the alkali itſelf; hence 100 grains of this ſalt would yield 80 of air, which in theſe circumſtances would weigh 14,52 grains. In another experiment I obtained ſtill leſs of this air, for 50 grains of this ſalt afforded only 34,962 cubic inches, the barometer indeed ſtood higher, namely at 30,26, and the thermometer only at 58.

FINDING this method inadequate to the diſcovery of the exact quantity of vol-alkali in this ſalt, I tried the effect of ſpontaneous evaporation on a mixture of this ſalt with lime and water, but ſoon found the quantity evaporated ſo great that it was very evident it did not proceed from the mere volatilization of the alkaline part, but in a great meaſure from that of the water alſo, hence I was obliged to content myſelf with detecting the proportion of the acid part.

FOR this purpoſe I made a ſolution of 400 grains cryſtallized nitrous ammoniac, and to this added a ſmall proportion of a ſolution of tartarin ſlightly aerated; as the point of ſaturation could not be aſcertained by any teſt, I added but little of the tartarin, and ſet the liquor to evaporate in a very gentle heat. The next day I found ſome cryſtals of nitre, which I carefully picked out, waſhed and dried, then added more tartarin to the mother liquor, ſet it to evaporate and cryſtallize as before. Thus I proceeded for ſeveral

ſeveral days and at laſt obtained 412 grains cryſtallized, well dried nitre. Now 412 grains nitre contain, by my account, 181,28 grains real nitrous acid, this quantity therefore exiſted in 400 grains of the nitrous ammoniac, conſequently 100 grains of this ſalt ſhould contain 45,3 of real nitrous acid.

THERE are however ſtrong reaſons to think that this ſalt contains much larger proportion of acid; for in the firſt place the ſalt volatilizes without decompoſition with the water that holds it in ſolution, as Berthollet obſerved in an experiment I ſhall preſently relate, and conſequently it is reaſonable to ſuppoſe that ſome eſcaped this way in my experiment, and moreover nitre is itſelf in ſome meaſure volatile during the evaporation of its ſolution, and laſtly, both Wenzel. Cornette and myſelf found a larger proportion of acid taken up by vol-alkali during the combination of both.

IN my laſt paper I ſtated the proportion of ingredients in nitrous ammoniac at 24 vol-alkali 78,75 ſtandard, which quantity is equivalent to 57,8 grains real acid, but noticed that there was an exceſs of acid. At preſent all due corrections made from this experiment, I infer that 100 grains cryſtallized nitrous ammoniac contain 57 nitrous acid, 23 of vol-alkali and 20 of water.

HENCE 100 grains vol-alkali take up 247,82 of nitrous acid, and ſhould afford 435 of cryſtallized nitrated vol-alkali, if there were no loſs in evaporation or no decompoſition.

AND

AND 100 grains nitrous acid ſhould take up 40,35 of vol-alkali, and *afford* 175,44 of ammoniac, if no loſs &c.

AN experiment of my own, related in my laſt paper, ſeems to contradict theſe reſults, for I there ſtated that 200 grains aerated vol-alkali, which contained 50 per cent. of fixed air, and conſequently the whole, 46 of vol-alkali, having been ſaturated with nitrous acid, to have afforded 296 of nitrated ammoniac, whereas by calculating from the above ſtatements they ſhould afford but 200: but the reaſon is, that the maſs of ſalt then procured was not wholly cryſtallized, but contained much of the mother liquor and an exceſs of acid which increaſed its weight. The only object I had then in view was to ſhew that the weight obtained was leſs than could be expected from the theory I had then formed, for this purpoſe it was not neceſſary to puſh the deficcation very far—a decompoſition alſo took place as will preſently be ſeen.

ACCORDING to Wenzel 240 grains of dry uncryſtallized nitrated vol-alkali contain 155,9 of his ſtrongeſt acid, 77,5 mere vol-alkali and 6,6 water: then 100 grains of this ſalt ſhould contain 64,95 acid, 32,29 vol-alkali, and 2,76 water. 123 grains of his aerated vol-alkali which contained 53,75 of fixed air, being ſaturated with nitrous acid, afforded him in one experiment 127 of nitrated vol-alkali, and in another 123; by my calculation, this quantity of vol-alkali ſhould afford 132,6 of the cryſtallized ſalt.

CORNETTE.

Cornette faturated 2304 grains of nitrous acid whofe fp. grav. was to that of water as 10 to 8, that is, 1,250 (he does not mention the temperature) with 1152 of an aerated vol-alkali extracted from fal ammoniac by a fixed alkali (he does not tell how much air it contained), and evaporating to drynefs obtained 1476 of uncryftallized nitrated vol-alkali, Mem. Par. 1783, p. 748.

If the fp. grav. of the acid were taken at 60° it would contain by my table 31,62 per cent. real acid, but if at 10° of Reuamur, as is ufual in France, it would contain 32 per cent. the concrete alkali being extracted by a fixed alkali which yields moft, cannot be fuppofed to contain lefs than 52 per cent. of fixed air, and confequently 24 per cent of mere vol-alkali, then 2304 grains of his acid contained 737,28 real nitrous acid, and 1152 of the aerated vol-alkali contained 281,48 of mere vol-alkali; and if 737,28 real nitrous acid take up 281,48 of mere vol-alkali, 100 grains of the acid fhould take up 38,2 nearly of vol-alkali which approaches nearly to my conclufion.

But as to the quantities of nitrated vol-alkali the difference is far greater; for if 737,28 grains of real acid faturated with vol-alkali afford 1476 of nitrated vol-alkali, 100 grains of this acid fhould afford 200 of this falt; whereas by my computation it fhould afford but 175,44.

These difcordant refults evidently fhew that a decompofition takes place in evaporating this falt in a heat even of 80°; the hydrogen

drogen of the vol-alkali partially decompofes the nitrous acid, and converts it either into nitrous air, which by contact with the atmofphere reforms nitrous acid, is reabforbed, and attracting more moifture forms the excefs of acid and increafe of weight which is fometimes found; or the acid is fo far decompofed as to become *rudimental nitrous air*, which is the fubftance Dr. Prieftly calls *dephlogifticated nitrous air*, which refufing all combination, flies off and occafions a lofs of weight; fometimes both changes take place.

Berthollet * diftilled 1152 grains of dry nitrated vol-alkali in a hydro-pneumatic apparatus, confifting of a retort, two enfiladed receivers, and a jar to receive air, 1080 grains paffed out of the retort into the receiver, confequently 72 grains only remained in the retort.

The enfiladed receivers contained 619 grains of a liquor highly acid, and much *rudimental nitrous air* (what Dr. Prieftly calls dephlogifticated nitrous air) was produced, the weight of this or other air and water, produced and loft, confequently amounted to 461 grains, for 1080 — 619 = 461.

To difcover the contents of the 619 grains of acid liquor he diftilled it in a water bath, there remained in the retort 320 grains

* Mem. Par. 1785, 316.

of ammoniac, which had not been decompofed by the 1ft diftilla-tion, but had paffed with the water into the enfiladed receivers, which proves that much of this falt is volatilized during the evaporation of its folution.

By this 2d diftillation an acid liquor paffed into the receiver, its weight muft have been 619 — 320 = 299 grains, thefe 299 grains he faturated with tartarin, the addition of which produced no fmell of vol-alkali, confequently no undecompofed vol-alkali remained. He then diftilled off the water and found it perfectly pure, there remained in the retort 54 grains of nitre, whence, depending on Bergman's calculation, he fuppofes the 299 grains of the acid liquor to have contained 18 grains of real nitrous acid, and that the remainder, viz. 281 grains muft have been water formed; hence he concludes, 1ft, that 760 grains of nitrated ammoniac were decompofed, for 72 + 320 = 392 efcaped during decompofition, and thefe being fubftracted from 1152, leave 760. 2dly, That from this decompofition 281 grs. of water had been produced, and even more, for fome was loft, p. 318. All thefe changes were effected by the 1ft diftillation.

I shall now examine this curious experiment on the grounds of the foregoing theory.

1ft,

1st, 760 grains of nitrated vol-alkali contain, by my account, 57 per cent. nitrous acid, 23 per cent. vol-alkali, and 20 per cent. water.

Confequently of acid		433,2
	vol-alkali	174,8
	water	152,00
		760

Again, 54 grains nitre contain, by my account, 23,76 real acid, and thefe, fubftracted from 433,2, leave 409,24 to form water and the rudimental nitrous air.

Hence 760 — 23,76 = 736,24 grains form the quantity to be accounted for; we muft alfo affign the reafon why rudimental nitrous air, and not mere nitrous air, was left.

2dly, Of the 281 grains of *water*, found by Berthollet, 152 pre-exifted by my theory, confequently the formation of 129, and of the additional quantity loft, muft be accounted for. To effect this we are to obferve,

3dly, That according to Berthollet's analyfis 100 grains vol-alkali confift of 19,34 of hydrogen, and 80,66 of mephite, confequently that 178,4 grains of vol-alkali contain 33,8 of hydrogen.

4thly, 100 grains water, by the moft exact experiment, require for their compofition 14,338 grains of hydrogen, confequently 129 grains of water require 18,497 of hydrogen, 9 Ann.

Chy. p. 45; consequently 129 grains water require 18,497 of hydrogen, consequently there remained 15,3 grains of hydrogen for the formation of about 100 grains more of water, which were lost.

5th. LAVOSIER assigns to 100 grains of fully oxyginated nitrous acid about 64 of nitrous air and 36 of acidifying oxygen; but in its common state of oxygination we may assign it 25 only of superadded oxygen; and consequently 100 grains of the common acid contain 75 of nitrous air and 25 of acidifying oxygen. Nitrous air itself contains about $\frac{2}{3}$ of its weight of oxygen, and $\frac{1}{3}$ mephite. 1 Lav. Elem. 235, and Mem. Par. 1781.

Now 100 grains water require for their formation 85,662 of oxygen, therefore 229 grains of water would require 196,16; but 409 grains nitrous acid, supposing it even fully oxyginated, contain no more than 147,24 of acidifying oxygen, therefore the remainder *v.z.* 48,92 must have been extracted from the nitrous air, and much more, if we suppose the nitrous acid to contain but 25 per cent. of acidifying oxygen; for then the nitrous acid would supply but 102,25, and consequently 93,91 should be taken from the nitrous air.

Now, according to the experiments of Dr. Priestly and Dieman, if much oxygen be substracted from nitrous air it will be converted into rudimental nitrous air; thus this conversion, and the quantity of water found, are adequately accounted for on the theory above laid down.

THE

The account of the reſults of this operation may be rendered ſtill clearer by the following table.

1080 grains paſſed into the receivers at the firſt diſtillation, namely,

		Grs.
	undecompoſed ammoniac -	320,
	undecompoſed nitrous acid -	23,76
	water of compoſition -	152,
	water produced - -	229,
	mephite of the vol-alkali - -	141,
Of 409 nitrous acid, from which its acidifying oxygen, namely, 102,25 grains, were extracted, there remained 306,95 grains of nitrous air; and of this, after the extraction of 93,91 of oxygen, there remained 212,84 of rudimental nitrous air.	rudimental nitrous air -	212,84
	Total - -	1078,60
	Loſs unaccounted for -	1,4
		1080,0

Remarks

Remarks on Mr. Richter's Calculation of the Proportion of Ingredients in Neutral Salts.

SINCE the publication of my last paper Mr. Richter, an able German Mathematician and natural philosopher, has published an elaborate treatise on the same subject, in which infinite labour and great mathematical ingenuity is displayed; his conclusions, however, differ considerably from mine; least this difference among so many experiments should suggest a doubt concerning the determinations I have endeavoured to establish, I feel myself obliged to investigate the source of this difference, and to shew the inaccuracy of several of his fundamental inductions.

Section 1st.

STOCHYOMETRY, 2 THEILE.

BY his first experiment, the foundation of several of his subsequent conclusions, he endeavours to discover the real quantity of calcareous earth in chalk, he found 2400 grains of chalk exposed in an *earthen* vessel to the greatest heat of a wind furnace (how long?) to weigh, when cool, only 1342 grains, therefore 1000 grains of this chalk would weigh 559 grains, and this without farther proof he takes to be the true quantity of lime contained in it.

ON

On this experiment I remark, that it does not clearly appear that the chalk was thoroughly calcined, but on the contrary there is great reafon to think it was not, becaufe chalk has never been known to contain fo large a proportion of lime as $\frac{559}{1000}$, it is true, he fays, it did not effervefce with acids, but furely it heated and bubbled, and fuch bubbles are not diftinguifhable from real effervefcence, where the quantity of fixed air is fmall, but by weighing before and after the addition of an acid, which he does not fay he had done.

Dr. Black found it impoffible to calcine any confiderable quantity of lime in an *earthen* crucible, but was obliged to ufe one of black-lead to avoid vitrifaction, 2 Ed. Effays, 219. Smith found the fame difficulty to effect the entire expulfion of fixed air, Differt. de Aere fixo, p. 40, 43. Chalk in general contains no more than 49 or 50 per cent. of fixed air, and the chalk he ufed, if it was purified, as he mentions in the 2d fection, muft have contained abundance of moifture; it commonly contains but 41 per cent. of fixed air, and the proportion of earth in fuch cafe is only 50 per cent. or $\frac{500}{1000}$, therefore $\frac{59}{1000}$ grains of fixed air remained unexpelled.

Section 3d.

5760 grains of fp. of falt were faturated with 2393 of the aforementioned chalk, and the whole being evaporated to drynefs and heated

heated to thin fuſion, weighed 2544 grains, now at the rate he had before laid down, the 2393 grains of chalk contained 1337 of lime, and deducting this from the ſalited maſs, he concludes the remainder, viz. 1207 to have been mere, or what I call real marine acid *. There the error committed in ſtating the quantity of lime is important, as from this the proportion of real acid in the ſp. of ſalt is deduced, and applied in calculating its proportion in other muriatic ſalts. If the chalk contained 50 per cent. of lime, as I ſtate it, then 2393 grains of it contained 1196 of lime, and deducting this from the 2544 of ſalited lime, the remainder, viz. 1348 is the quantity of real muriatic acid contained in that maſs, and conſequently that which is contained in 5760 grains of his ſp. of ſalt, and 1000 grains of it contained 234,03 nearly, inſtead of 209, as he ſtates it.

Section 33d.

I PASS to this ſection, as it is here that the defect of his determination will more clearly appear. In this he tells us, that he ſaturated 1760 grains of a ſolution of mild vegetable alkali with 2740 grains of the above mentioned ſp. of ſalt, evaporated and fuſed the neutral ſalt thus formed, and found it to weigh 1856 grains, whence, as by his ſtatement, 2740 grains of that ſp. of ſalt contained

* By an error of the preſs it is ſtated in the original that 1207, 2544 :: 1000, 1103.

tained 573 of real acid, and this quantity entered into the 1856 grains of neutral ſalt, it follows that by ſubſtracting 573 from 1856 the remainder will exhibit the weight of the alkali, namely, 1283 grains.

It muſt be allowed that this is a very indirect and improper method of diſcovering the real quantity of mild alkali in the alkaline ſolution, for it comes loaded with the inaccuracies attending the two previous determinations, that of the real quantity of lime, from which that of the marine acid is inferred, and that of the marine acid, from which this laſt determination is deduced; beſides, if any muriated tartarin exiſted in the alkaline ſolution, as it often does, it would eſcape this method and could not be detected.

But a more apparent objection lies to it; if 1586 grains of muriated tartarin contain only 573 of real acid, then 100 grains of this ſalt would contain only 30,86; now if any thing be well proved in my eſſay, it is aſſuredly the aſſertion, that 100 grains of this ſalt contain nearly 36 of real acid, being confirmed by the experiments on ſalited ſilver, and the decompoſition of common ſalt, therefore Richter's determination is erroneous, by allowing to this ſalt too ſmall a proportion of acid.

But if we determine the quantity of alkali in the 5760 grains of alkaline ſolution by the quantity of real marine acid it was able

to ſaturate, calculated as I mentioned in the above experiment on lime, it will be found very exactly; for there I ſtated that 5760 grains of his ſp. of ſalt contained 1348 of real acid, and conſequently 2740 contained 641,25. Now as 36 of acid take up 64 of vegetable alkali, 641,25 take up 1140 of that alkali, and the ſum of both *v. z.* 1781, will be the quantity of muriated tartarin thus formed. It is true he found its weight to be 1856 grains, that is 75 grains more than by my calculation, but this exceſs moſt probably was cauſed by the muriated tartarin previouſly exiſting in his alkaline ſolution. His mode of obtaining what he calls a pure alkaline ſolution renders this highly probable.

To obtain a pure alkali (§ 33) he ſimply pours cold water on common pot-aſh, and leaves them together, frequently agitating them for 24 hours; the ſolution thus obtained he evaporates to dryneſs, and then again treats the ſaline maſs with cold water, but with a quantity of it too ſmall to re-diſſolve the whole; ſuch was the alkaline ſolution he employed. Now though much of the neutral ſalts contained in pot-aſh may thus remain undiſſolved, yet ſome certainly will be taken up, and among the reſt muriated tartarin, which is frequently found in vegetable aſhes * and does not require above three times its weight of water to diſſolve it. To this, then, the exceſs of 75 grains may well be aſcribed.

The juſtneſs of this concluſion is ſtill further confirmed by examining his experiment on vitriolated tartarin. He ſaturated another

* Wiegleb. uber die Alkaliſche Salze 98.

ther pound of the alkaline ſolution with 3647 grains of dilute vitriolic acid, and after evaporation and ignition found the ſalt to weigh 2090 grains, and as he thinks he has proved the quantity of alkali in 5760 grains of the alkaline ſolution to be 1283 grains, hence he concludes the quantity of acid in the 2090 grains to be 2090 — 1283 = 807 grains; if ſo, vitriolated tartarin ſhould contain but 38,6 grains per cent. of acid, whereas it has been proved to contain much more.——But allowing the quantity of alkali in the pound of alkaline ſolution to be, as I ſtated it, 1140 grains, then as 55 parts alkali take up 45 of real vitriolic acid, 1140 will take up 933 of this acid, and the ſum of both will be 2073, which differs from 2090 only by 17 grains, owing probably to the muriated tartarin contained in his alkaline ſolution, which may even have been decompoſed by the vitriolic acid. He determined, it is true, the quantity of vitriolic acid by another operation, § 18, but here a material and evident error occurs, as I ſhall preſently ſhew:

1ſt, To 8460 grains of vitriolic acid, whoſe ſp. grav. was 1,8553, he added 19200 of water, or, which is the ſame thing, to 84,6 of the concentrated acid he added 192 of water, and found the ſp. grav. of the mixture 1,214.

2dly, He ſaturated 9075 grains of this dilute acid with 3215 grains of the chalk above-mentioned, and as by his account 1000 parts of that chalk contained 559 of lime, he concluded that

 3215

3215 grains of it contained 1596 of lime. Then having heated the ſelenite thus formed to a degree ſufficient to convert lime-ſtone into lime, he found it to weigh 3600 grains, and deducting from this weight that of the lime, he found the remainder, *v. z.* 2004 grains to be the weight of the vitriolic acid which was contained in 9075 grains of the dilute acid liquor, and conſequently that the 3647 grains of it which he had employed in ſaturating the alkali in the former experiment contained 806 grains.

HERE, not to repeat with reſpect to the chalk what I have already ſuggeſted, I ſhall confine myſelf to a *ſingle* error, becauſe it is manifeſt:

As 1000 parts chalk (he ſays) contain 559 of lime, 3215 grains of it ſhould contain 1596, whereas by the rule of proportion it ſhould be 1797,185; then deducting 1797 from 3600, the remainder, *v. z.* 1803, and not 2004, ſhould be the weight of the acid part of the ſelenite; and 3647 grains of the dilute acid employed in ſaturating the alkali ſhould contain, by his own account, 722, and not 806 grains. It would ill become me to reproach Mr. Richter with this overſight, as many of ſuch have often eſcaped my notice in my own calculations, and occaſioned me infinite labour in rectifying their numerous ſpurious conſequences.

TABLE

T A B L E II.

Quantity of Real Acid taken up by mere Alkalis and Earths.

100 Parts.	Vitriolic.	Nitrous.	Marine.	Fixed Air.
Tartarin -	82,48	84,96	56,3	105 almoft
Soda - -	127,68	135,71	73,41	66,8
Vol-alkali -	383,8	247,82	171	Variable
Barytes -	50	56	31,8	282
Stronthian -	72,41	85,56	46	43,2
Lime -	143	179,5	84,488	81,81
Magnefia -	172,64	210	111,35	200 Fourcroy
Argill - -	150,9			335 nearly Berg.

TABLE III.

Of the Quantity of Alkalis and Earths taken up by 100 Parts of Real Vitriolic, Nitrous, Muriatic and Carbonic Acids, faturated.

100 Parts	Tartarin.	Soda.	Vol-Alkali.	Barytes.	Stronthian.	Lime.	Magnefia.
Vitriolic - - - -	121,48	78,32	26,05	200,	138,	70,	57,92
Nitrous - - - -	117,7	73,43	40,35	178,12	116,86	55,7	47,64
Muriatic - - - -	177,6	136,2	58,48	314,46	216,21	118,3	89,8
Carbonic - - - -	95,1	149,6	— —	354,5	231, +	122,	50,

TABLE IV.

Quantity of Neutral Salts afforded by 100 Parts of the above-named Acids when faturated with the above-named Bafes.

100 Parts	Tartarin.	Soda.	Vol-Alkali.	Barytes.	Stronthian.	Lime.	Magnefia.
Vitriolic	221,48	{ 425 cryftallized 178,5 deficcated }	182,94	300	238	{ 170 in a white heat 198 at 170°	340 cryftallized 158 deficcated
Nitrous	227,22	188	175,44			174 well dried, that is, in air	
Marine	277,6	257,2	233,9	{ 487,4 cryftallized 454,5 deficcated }	540 cryftallized 313,5 deficcated	238 in a red heat	286,2 well dried
Carbonic	232,5	{ 693,5 cryftallized 150 deficcated }		454,5	331,7	222,25	200

100 Parts with	Vitriolic.	Nitrous.	Marine.	Carbonic Acids.
Tartarin - -	182,48	193 +	156,3	244
Soda - -	541,1 crystallized 227,4 deficcated	246,42	188,74	463,3 crystallized 167 deficcated
Vol-alkali -	702,94	435	400	
Barytes -	150		155,16 crystallized 142,8 deficcated	382
Stronthian -	172,41		250 crystallized 145 deficcated	143,16
Lime - -	312 dried at 50° 284 dried at 130° 262,8 ignited 243 incandefcent	312 dried at 80° 280 fully deficcated	200 in a red heat	182
Magnefia - -	588,23 cryftallized 272,62 deficcated		321,8 ge tly but fenfibly dried.	400

T A B

Of the Proportion of Ingredients

100 Parts *Carbonic.*	Basis.	Acid.	Water.	
Aerated Tartarin - -	41, - -	43,	16, - -	Crystalli
Common Salt of Tartarin or Pearl Ash	60, - - -	30,	6 - -	Dry.
Aerated Soda - -	21,58 - -	14,42	64, - - -	Fully cry
Do. - -	59,86 - -	40,05	- - - -	Desiccat
Aerated Barytes - -	78, - - -	22,	- - - -	Natural
Aerated Stronthian - -	69,5 - -	30,	- - - -	Natural
Aerated Lime -	55, - -	45,	- - - -	Natural i
Aerated Magnesia - -	25, - - -	50,	25, - - -	Crystalli
Common Magnesia - -	45, - -	34,	21, - -	Dried at
Aerated-Vol alkali - -	In the Ratio of 6 to 13 fixed Air	to	13 fixed Air.	
Vitriolic.				
Vitriolated Tartarin - -	54,8 - -	45,2	- - - -	Dry.
Glauber - - -	18,48 - -	23,52	58, - - -	Fully cry

TABLE VI.

Of the Proportion of Ingredients in the following Saline Compounds:

Bafis.	Acid.	Water.	State.	100 Parts *Nitrous.*	Bafis.	Acid.	
41,	43,	16,	Cryftallized.	Nitre	51,8	44,	4,2 of
60,	30,	6	Dry.	Nitrated Soda	40,58	53,21	6,21 o
21,58	14,42	64,	Fully cryftallized.	Do.	42,34	57,55	-
59,86	40,05	-	Deficcated.	Nitrated Vol-alkali	23,	57,	20,
78,	22,	-	Natural or ignited.	Nitrated Barytes	57,	32,	11,
69,5	30,	-	Natural or ignited.	Nitrated Stronthian	36,21	31,07	32,72
55,	45,	-	Natural if pure, or artificial ignited.	Nitrated Lime	32,	57,44	10,56
25,	50,	25,	Cryftallized.	Nitrated Magnefia	22,	46,	22,
45,	34,	21,	Dried at 80°.				
In the Ratio of 6 to 13 fixed Air	to	13 fixed Air.					
				Muriatic.			
54,8	45,2	-	Dry.	Muriated Tartarin	64,	36,	-
18,48	23,52	58,	Fully cryftallized.	Common Salt	53,	47, aqueous, 38,88 real	-

in the following Saline Compounds:

State.	100 Parts *Nitrous.*	Bafis.	Acid.	Water.	State.
zed.	Nitre -	51,8	44, - -	4,2 of Compofition	Dried at 70°.
	Nitrated Soda -	40,58	53,21 - -	6,21 of Compofition	Dried at 400°.
yftallized.	Do. -	42,34	57,55 - -	- - -	Ignited.
ed.	Nitrated Vol-alkali	23,	57, - -	20, - -	
or ignited.	Nitrated Barytes -	57,	32, - -	11, - -	Cryftallized.
or ignited.	Nitrated Stronthian	36,21	31,07 - -	32,72 - -	Cryftallized.
f pure, or artificial ignited.	Nitrated Lime -	32,	57,44 - -	10,56 - -	Well dried, that is in Air.
zed.	Nitrated Magnefia	22,	46, - -	22, - -	Cryftallized.
80°.					
	Muriatic.				
	Muriated Tartarin -	64,	36, - -	- - -	Dried at 80°.
ftallized.	Common Salt -	53,	47, aqueous, 38,88 real	- - -	Dried at 80°.

Aerated Tartarin	41,	43,	16,	Cryſtalli
Common Salt of Tartarin or Pearl Aſh	60,	30,	6	Dry.
Aerated Soda	21,58	14,42	64,	Fully cry
Do.	59,86	40,05	-	Deficcat
Aerated Barytes	78,	22,	-	Natural
Aerated Stronthian	69,5	30,	-	Natural
Aerated Lime	55,	45,	-	Natural i
Aerated Magneſia	25,	50,	25,	Cryſtalli
Common Magneſia	45,	34,	21,	Dried at
Aerated-Vol alkali	In the Ratio of 6 to 13 fixed Air	to	13 fixed Air.	
Vitriolic.				
Vitriolated Tartarin	54,8	45,2	-	Dry.
Glauber	18,48	23,52	58,	Fully cry
Do.	44,	56,	-	Deficcate
Vitriolated Vol-alkali	14,24	54,66	31,1	
Baroſelenite	66,66	33,33	-	Natural a
Vitriolated Stronthian	58,	42,	-	Natural a
Selenite	32,	46,	22,	Dried at
Do.	35,23	50,39	14.38	Dried at
Do.	38,81	55.84	5,35	Ignited.
Do.	41,	59,	-	Incandeſc
Epſom	17,	29,35	53,65	Fully cry
Do.	36,68	63,32	-	Deficcate
Allum	12, ignited	17,66	51, of Cryſtal + 19,24 in the Earth	Cryſtalliz
Do.	63,75	36,25	-	Deficcate
Vitriols				
Of Iron	28, Ψ of ♂ = 12, Metal	26,	38, + 8 of Compoſition	Cryſtalliz
Do.	45,	41,93	13,07	Calcined
Lead	75, Calx = 71 Metal	23,37	1 ,63	
Copper	[illegible] Calx [illegible] Metal			

41, - -	43,	16, - -	Cryſtallized.	Nitre -	51,8	44, - -	4,
60, - - -	30,	6 - -	Dry.	Nitrated Soda -	40,58	53,21 - -	6,
21,58 - -	14,42	64, - - -	Fully cryſtallized.	Do. -	42,34	57,55 - -	-
59,86 - -	40,05	- - - -	Deficcated.	Nitrated Vol-alkali	23,	57, - -	20,
78, - - -	22,	- - - -	Natural or ignited.	Nitrated Barytes -	57,	32, - -	11,
69,5 - -	30,	- - - -	Natural or ignited.	Nitrated Stronthian	36,21	31,07 - -	32,
55, - -	45,	- - - -	Natural if pure, or artificial ignited.	Nitrated Lime -	32,	57,44 - -	10,
25, - - -	50,	25, - - -	Cryſtallized.	Nitrated Magneſia	22,	46, - -	22,
45, - -	34,	21, - -	Dried at 80°.				
In the Ratio of 6 to 13 fixed Air	to	13 fixed Air.					
				Muriatic.			
54,8 - -	45,2	- - - -	Dry.	Muriated Tartarin -	64,	36, - -	-
18,48 - -	23,52	58, - - -	Fully cryſtallized.	Common Salt -	53,	47, aqueous, 38,88 real	-
44, - -	56,	- - - -	Deficcated at 700°.	Sal Ammoniac -	- -	- - -	-
14,24 - -	54,66	31,1 - -		Do. -	25,	42,75 - -	32,2
66,66 - -	33,33	- - - -	Natural and pure, artificial ignited.	Muriated Barytes -	64,	20, - -	16,
58, - -	42,	- - - -	Natural and pure, artificial ignited.	Do. -	76,2	23,8 - -	-
32, - -	46,	22, - - -	Dried at 66°.	Muriated Stronthian	40,	18, - -	42,
35,23 -	50,39	14,38 - - -	Dried at 170°.	Do. -	69,	31, - -	-
38,81 - -	55,84	5,35 - - -	Ignited.	Muriated Lime -	50,	42, - -	8,
41, - -	59,	- - - -	Incandeſcent.	Muriated Magneſia	31,07	34,59 - -	34,3
17, - -	29,35	53,65 - - -	Fully cryſtallized.	Muriated Silver -	75,	16,54 - -	8,4
36,68 - -	63,32	- - - -	Deficcated.	Muriated Lead -	81,77 ♆ ♄	18,23 - -	In t
12, ignited - -	17,66	51, of Cryſtal + 19,24 in the Earth	Cryſtallized.	Do. -	83, ♆ of ♄	17, - -	-
63,75 - -	36,25	- - - -	Deficcated at 700°.				
28, ♆ of ♂ = 12, Metal	26,	38, + 8 of Compoſition -	Cryſtallized.				
45, - -	41,93	13,07 - -	Calcined to Redneſs.				
75, Calx = 71 Metal -	23,37	1 ,63 - - -					

zed.	Nitre -	51,8	44, - -	4,2 of Compofition	Dried at 70°.
	Nitrated Soda -	40,58	53,21 - -	6,21 of Compofition	Dried at 400°.
yftallized.	Do. -	42,34	57,55 - -	- - -	Ignited.
ed.	Nitrated Vol-alkali	23,	57, - -	20, - -	
or ignited.	Nitrated Barytes -	57,	32, - -	11, - -	Cryftallized.
or ignited.	Nitrated Stronthian	36,21	31,07 - -	32,72 - -	Cryftallized.
f pure, or artificial ignited.	Nitrated Lime -	32,	57,44 - -	10,56 - -	Well dried, that is in Air.
zed.	Nitrated Magnefia	22,	46, - -	22, - -	Cryftallized.
80°.					
	Muriatic.				
	Muriated Tartarin -	64,	36, - -	- - -	Dried at 80°.
ftallized.	Common Salt -	53,	47, aqueous, 38,88 real	- - -	Dried at 80°.
d at 700°.	Sal Ammoniac -	- -	- - -	- - -	Cryftallized.
	Do. -	25,	42,75 - -	32,25 - -	Sublimed.
nd pure, artificial ignited.	Muriated Barytes -	64,	20, - -	16, - -	Cryftallized.
nd pure, artificial ignited.	Do. -	76,2	23,8 - -	- - -	Deficcated.
66°.	Muriated Stronthian	40,	18, - -	42, - -	Cryftallized.
170°.	Do. -	69,	31, - -	- - -	Deficcated.
	Muriated Lime -	50,	42, - -	8, - -	Red hot.
cent.	Muriated Magnefia	31,07	34,59 - -	34,34 - -	Senfibly dry.
ftallized.	Muriated Silver -	75,	16,54 - -	8,46 Oxygen -	Dried at 130°.
d.	Muriated Lead -	81,77 ♆ ♄	18,23 - -	In the Calx -	Cryftallized.
ed.	Do. -	83, ♆ of ♄	17, - -	- - -	Deficcated.
d at 700°.					
ed.					
to Rednefs.					

Do.	44,	56,	-	Deficcate
Vitriolated Vol-alkali	14,24	54,66	31,1	
Barofelenite	66,66	33,33	-	Natural a
Vitriolated Stronthian	58,	42,	-	Natural a
Selenite	32,	46,	22,	Dried at
Do.	35,23	50,39	14.38	Dried at
Do.	38,81	55,84	5,35	Ignited.
Do.	41,	59,	-	Incandefc
Epfom	17,	29,35	53,65	Fully cry
Do.	36,68	63,32	-	Deficcate
Allum	12, ignited	17,66	51, of Cryftal + 19,24 in the Earth	Cryftalliz
Do.	63,75	36,25	-	Deficcate
Vitriols				
Of Iron	28, ♆ of ♂ = 12, Metal	26,	38, + 8 of Compofition	Cryftalliz
Do.	45,	41,93	13,07	Calcined
Lead	75, Calx = 71 Metal	23,37	1 ,63	
Copper	40 Calx = 30 Metal	31,	29,	
Zinc	40 Calx = 30 Metal	20.5	39,	

44,	56,	-	Deficcated at 700°.	Sal Ammoniac	-	-
14,24	54,66	31,1		Do.	25,	42,75
66,66	33,33	-	Natural and pure, artificial ignited.	Muriated Barytes	64,	20,
58,	42,	-	Natural and pure, artificial ignited.	Do.	76,2	23,8
32,	46,	22,	Dried at 66°.	Muriated Stronthian	40,	18,
35,23	50,39	14.38	Dried at 170°.	Do.	69,	31,
38,81	55,84	5,35	Ignited.	Muriated Lime	50,	42,
41,	59,	-	Incandefcent.	Muriated Magnefia	31,07	34,59
17,	29,35	53,65	Fully cryftallized.	Muriated Silver	75,	16,54
36,68	63,32	-	Deficcated.	Muriated Lead	81,77 Ψ ♄	18,23
12, ignited	17,66	51, of Cryftal + 19,24 in the Earth	Cryftallized.	Do.	83, Ψ of ♄	17,
63,75	36,25	-	Deficcated at 700°.			
28, Ψ of ♂ = 12, Metal	26,	38, + 8 of Compofition	Cryftallized.			
45,	41,93	13,07	Calcined to Rednefs.			
75, Calx = 71 Metal	23,37	1 ,63				
40 Calx = 30 Metal	31,	29,				
40 Calx = 30 Metal	20.5	39,				

d at 700°.	Sal Ammoniac -	- -	- - -	- - -	Cryftallized.
	Do. -	25,	42,75 - -	32,25 - -	Sublimed.
nd pure, artificial ignited.	Muriated Barytes -	64,	20, - -	16, - -	Cryftallized.
nd pure, artificial ignited.	Do. -	76,2	23,8 - -	- - -	Deficcated.
66°.	Muriated Stronthian	40,	18, - -	42, - -	Cryftallized.
170°.	Do. -	69,	31, - -	- - -	Deficcated.
	Muriated Lime -	50,	42, - -	8, - -	Red hot.
cent.	Muriated Magnefia	31,07	34,59 - -	34,34 - -	Senfibly dry.
ftallized.	Muriated Silver -	75,	16,54 - -	8,46 Oxygen -	Dried at 130°.
d.	Muriated Lead -	81,77 ♆ ♄	18,23 - -	In the Calx -	Cryftallized.
ed.	Do. -	83, ♆ of ♄	17, - -	- - -	Deficcated.
d at 700°.					
ed.					
to Rednefs.					